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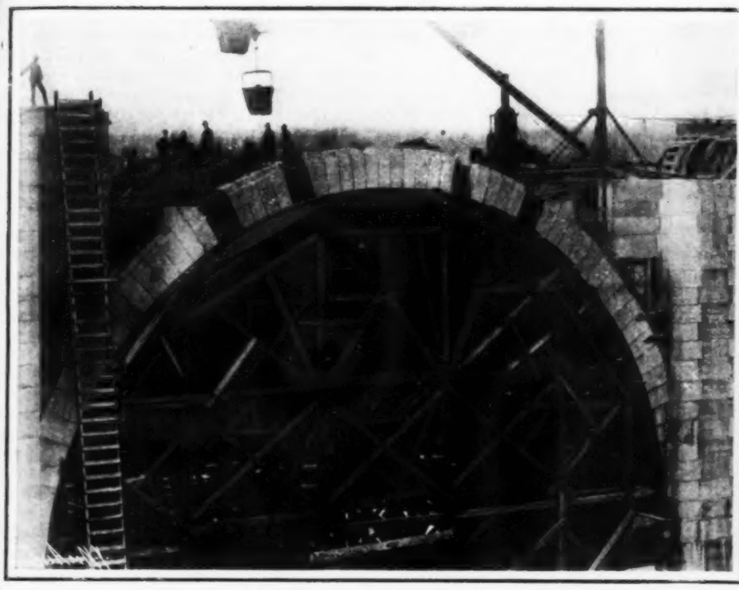
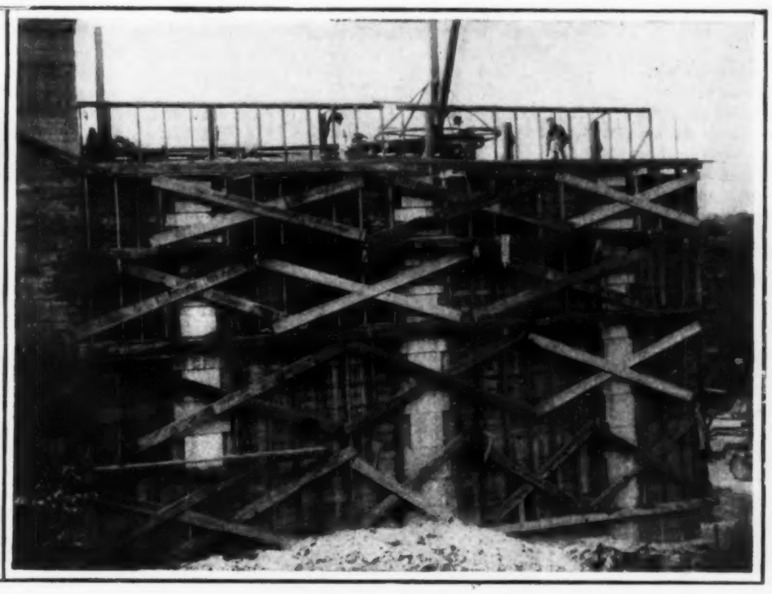
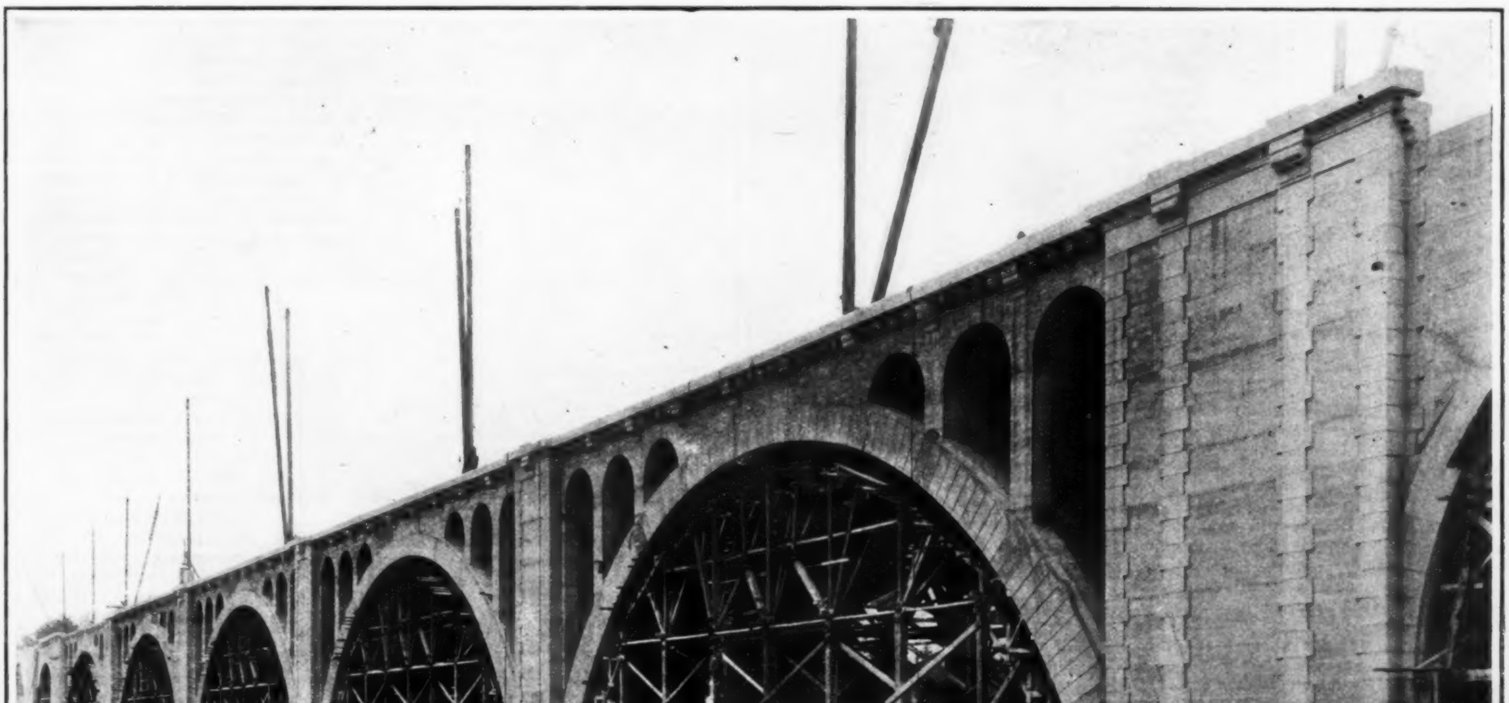


ONE OF THE ARCHES DURING CONSTRUCTION.



FALSE WORK AT ONE OF THE PIERS.



THE BRIDGE FROM THE NORTH SIDE, NEARLY COMPLETED; A PART OF THE OLD STRUCTURE ON THE LEFT.

THE CONNECTICUT AVENUE CONCRETE BRIDGE, WASHINGTON.

WASHINGTON'S GREAT CONCRETE BRIDGE.

By FRANK N. BAUSKETT.

THE new Connecticut Avenue Bridge at Washington, D. C., the largest of its kind in the world, is about to be opened. Mr. W. J. Douglass, District Engineer of Bridges, who has the work in charge, hopes to throw its portals open to public traffic on March 1, 1907. This handsome structure, measuring 1,450 feet in length, is built entirely of concrete. It stands on a foundation which is of hard rotten rock. The total cost of the causeway, when completed, will be $850,000, or $11 a square foot. In its building 100,000 tons of broken stone have been used, with 34,000 tons of sand and 14,300 tons of cement. If the number of trips required by the wagons to haul this material were put into lineal miles the distance traveled would make something less than ten times the circumference of the earth, for approximately 226,000 miles have been traversed by the teams hauling the material for the construction of this magnificent bridge. The bridge spans an insignificant little stream, running through the most fashionable and picturesque section of the district known as Rock Creek Valley, and its building has enhanced the value of real estate in the vicinity at least 100 per cent.

The bridge consists of five 150-foot and two 80-foot arches, making a total length of 1,450 feet. Its total width is 52 feet, with a 32-foot roadway, and a sidewalk on either side 6 feet in width. Mr. Douglass estimates that the structure now contains nearly three times as much masonry as any similar structure in existence. To construct the false work 1,500,000 feet of lumber, costing the city $54,000, has been used, while the total amount required will reach 2,500,000 feet. "If this great quantity of timber were placed end to end," says the engineer, "it would be of sufficient length to build a boardwalk two feet in width from the White House to the State Capitol building at Albany, New York." Over 80,000 barrels of cement were emptied and worked with sand and stone into concrete, for the construction of the seven arches and five huge piers of the bridge, which rises to a maximum height of 132 feet above ground. If these 80,000 barrels of cement were placed end to end on top of each other they would be nearly as high as the tallest mountain in the world; they would extend heavenward to a height of 27,000 feet. Practically all the stone used in the constructon of the bridge was quarried within 500 feet of the structure on ground purchased by the contractors for the purpose. A private quarry was installed on this property, and by this arrangement it is estimated that the contractors saved at least $60,000 on this project.

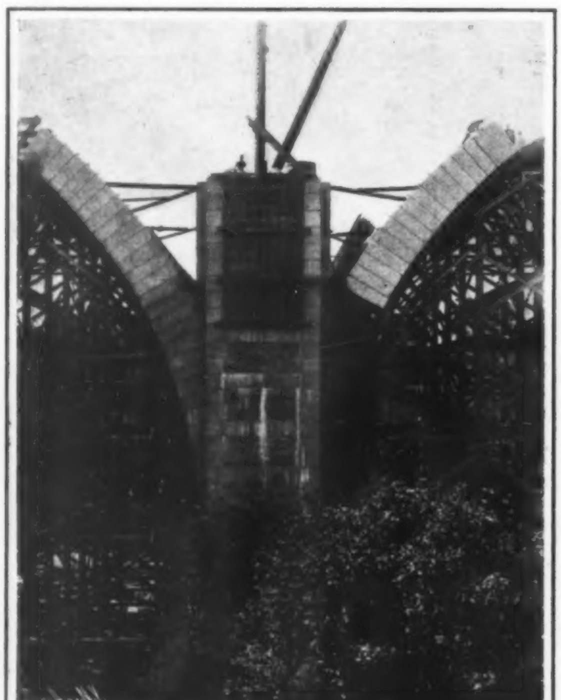
The lumber used for the false work of the bridge was brought from the yellow pine forests of Georgia. One and a half million feet of this timber, when taken from the arches of the bridge, will be shipped to New York city, where it will again do duty in the superstructure of a great dam now in course of construction there.

Eight 90-foot derricks, the largest of the kind ever used in Washington, were employed for months in the erection of the false work of the bridge. The big poles which supplied these derrick frames were brought especially from the forests of Oregon, their length being so great as to necessitate the use of three flat cars coupled together to accommodate them.

While little now remains to be done on the bridge, with the exception of putting on the finishing touches, the District Engineer of Bridges will not be prepared to open the bridge for public traffic until about $40,000 more have been spent; this sum will be expended for the temporary construction of roadway and sidewalks, and for ornamental work. It is necessary to lay temporary sidewalks and roadway over the bridge in order to give time for the settling of the earth fill over the arches, which will require about one year. Then the permanent roadway and sidewalks will be constructed.

The bridge will be lighted by twenty-four ornamental lamps, twelve on each side, each lamp supporting two Nernst lights, which exceed in brightness the ordinary electric arc light.

The bridge will be thrown open with appropriate ceremony on March 1, and when the barriers are lowered to the public the completed structure will stand as a notable monument to the skill of its engineers and the memory of its original designer, the late George S. Morrison.



ONE OF THE PIERS AND TWO ARCHES DURING CONSTRUCTION.

THE CONNECTICUT AVENUE CONCRETE BRIDGE, WASHINGTON.

SAFE SUBMARINE VESSELS AND THE FUTURE OF THE ART.*

By SIMON LAKE.

THE United States government, in 1893, when contemplating entering the field of "submarine" experiment, set up a certain standard of requirements, which were placed in the following order: First, safety; second, facility and certainty of action when submerged; third, speed when running on the surface; fourth, speed when submerged; fifth, endurance, both submerged and on the surface; sixth, offensive power; seventh, stability; and eighth, visibility of object to be attacked.

At this time France was the only other country giving official encouragement to the development of the submarine as a weapon of defense, and from the discouraging results attained by their "Gymnote"—a boat of the diving type—there was little to encourage other governments to venture into this field of naval warfare. Mr. Nordenfelt had built several submarines in England which failed to meet with the success that might have been attained had he provided greater stability in his craft. That he recognized that the cause of failure in his boats was principally this lack of stability is shown by his statement to the effect that submarine navigation would never be successfully accomplished until boats were built capable of navigating on a level keel. The conclusions drawn by Mr. Nordenfelt after his experiments, and the requirements prescribed by the United States Navy Department in 1893, have been my guiding principles during the past thirteen years of practical effort. From my experience I should place longitudinal stability as the second requirement in order of importance. The greater the longitudinal stability, the greater the speed which may be safely attained when running either on the surface or submerged. The offensive appliances may also be operated with much greater certainty in a craft which is not liable to stand on her end on slight provocation. Visibility of objects may also be much better secured in a craft with great longitudinal stability, and operating on a level keel.

There are official records of twenty-four accidents to submarine vessels, seven of which have been attended with fatal results—117 lives having been lost. In looking over the list of accidents it is plain that the greatest number of lives have been sacrified by reason of four causes, and, taking these in the order of their fatal responsibility, we have, first, lack of longitudinal stability; second, carelessness; third, explosions; and fourth, collisions. As asphyxiation has come very near to producing fatalities in several instances, it may be considered as the fifth cause.

My first experience was with a small wooden craft, 14 feet in length, built in 1894, and named "Argonaut, Jr." It was a crude, coffin-shaped vessel propelled by hand-power, which revolved toothed wheels resting with sufficient weight upon the water-bed to give the necessary tractive force when submerged.

After having been submerged in the "Argonaut, Jr.," on one occasion for over two hours, it was discovered that so much water had leaked into the water-ballast compartments that the boat would not rise when the anchor weights were released. Fortunately, a drop-keel of 600 pounds had been provided, which, when released, gave the vessel the buoyancy needful to bring her quickly to the surface. On looking over the list of accidents it will be seen that the lives of the crews of at least three French boats have probably been saved by the prompt release of their drop-keels; and it is said that the French have generally adopted this feature in all their modern under-water craft.

The "Hunley's" fatalities might have been avoided had she been provided with a drop-keel. Owing to the lack of longitudinal stability, she was fou[illegible]e times at the bottom of the river, end up, and her crews dead from suffocation in the lower end, where they had been thrown by her sudden downward pitch. From this position they were unable to operate the pumps—the only means designed to bring her to the surface should her diving-rudders fail to control her. According to the best information I have been able to obtain, the "A 1" might have been saved had she been provided with a drop-keel, as the published reports show that only a small quantity of water had leaked in as the immediate result of the blow struck her by the "Berwick Castle." Loss of control caused the American diving-boat "Porpoise" to accidentally plunge to a depth of 125 feet, and she was brought to the surface only after three-quarters of an hour of desperate hand-pumping. It took that length of time to pump the small quantity of water out of one of the forward trimming tanks in order to give her an upward inclination by the bow. The propeller was then started at full speed, and the vessel was thus driven to the surface.

My next boat, the "Argonaut," 36 feet in length, was the first submarine to be fitted with internal-combustion engines. Her construction was commenced in 1896. Built-up fuel tanks were provided within her hull, as is the usual practice in the majority of submarines. These tanks were made as tight as possible and tested by hydraulic pressure up to 20 pounds per square inch without showing the slightest leakage. When it became time for our first trials, fuel was put in these tanks the evening before and the boat sealed for the night. Notwithstanding the precautions taken, on opening the hatches next morning the smell of gasoline was so strong within the boat that, knowing the dangers associated with light hydrocarbons, I did not consider it safe to make a run. Our trials were delayed until new tanks could be made and fitted outside the hull. The fumes from gasoline naturally collect in the lower parts of a submarine vessel, where their presence may be entirely unsuspected, even by odor.

It is my belief that the best way to be entirely rid of this danger is to remove the fuel-tanks from within the main hull and to place them outside.

Our first attempt to use gasoline engines developed an entirely unforeseen difficulty. The engine was of the inclosed type, and had been carefully constructed for submarine work. Knowing that gasoline fumes are heavy, and conscious that the vitiated air and carbonic-acid gas given off by breathing would naturally settle to the floor, a receiving, or settling, pit had been provided for the purpose of collecting these heavy gases, and an induction-pipe was led to this pit, so that the suction of the intake of the engines would automatically take up these gases and expel them with the engine exhaust. The "Argonaut" was designed to run either on the surface or under water, using her main engines at all times for propulsion. During our first trials she worked very satisfactorily, and we remained submerged for a period of over two hours; but shortly before the completion of the interval I noticed that the crew showed signs of considerable exhaustion. For myself, I felt weak; perspiration started out all over my body, and there was severe pain at the base of my brain. Realizing that something was wrong, the vessel was brought to the surface and anchored. One of the crew collapsed entirely as soon as he got out of the boat, and all of us were more or less affected on reaching the fresh air.

The next day we made another submergence for the purpose of finding out, if possible, the cause of the distress experienced the day before. Everything worked well for the first hour, but toward the end of the second hour there was a recurrence of the symptoms and the distress manifested on the previous day. The trouble had been caused by occasional back explosions, which, coming out through the induction-pipe leading to the settling pit, had been forced into the boat. One of the products of that combustion was carbon monoxide, which is a deadly poison. The following remedy was found and applied: The induction pipe was connected with an induction tank large enough to take the volume of any back explosions, the induction tank being fitted with a check-valve which permitted the air to pass through the induction-tank and then into the induction-pipe of the engine; but if a back

* Abstract of a paper read before the Institution of Naval Architects.

explosion occurred, the check-valve seated and prevented the products of combustion coming out into the compartment. If the products of combustion backed up into the induction-tank, the next revolution of the engine drew them out again. We have never experienced any trouble from this cause since, although we have run submerged under gasoline propulsion for a period of more than ten hours at a time. Gasoline engines are now well-nigh universally used on submarine boats, and numerous cases have been reported where asphyxiation has occurred with nearly fatal results. With the proper installation, the running engines induce sufficient ventilation to keep the air within a submarine especially pure and fresh; but the reverse is the result if the installation fails to provide effectually against back explosions or leakages.

The "Argonaut" worked satisfactorily in the rivers tributary to the Chesapeake, and also during our runs in the bay itself. It was finally decided to take her out to the open sea, and to test her in rough weather—something which had not until then, so far as my knowledge goes, been attempted with any submarine. Our first attempt at submergence was made 5 miles off the Virginia coast, at a depth of about 35 feet. It was found that the wave motion reached even to the water-bed; and, in attempting to propel the boat, she would strike the bottom and rebound to the surface, owing to the lifting effect of the submarine waves or ground swell. The "Argonaut" at that time navigated over the bottom on three wheels, two in span forward and one aft attached to the rudder, and serving, when traveling in this way, as the guiding wheel. The forward wheels and their connecting shafting were very heavy. They were driven by a worm-and-wheel attachment inside of the boat. The worm-wheel had a hub 11 inches in diameter, yet so great was the striking force of the vessel on the bottom that this hub was split by shock after we had been submerged only a few minutes, and to keep the boat herself from bounding on the bottom it was found necessary to give her a negative buoyancy of about 1,500 pounds, under which condition it was found possible to navigate her easily upon the water-bed of hard sand. This experience brought about a modification of the boat in the form of smaller wheels, fitted to swinging arms. These allowed the boat to lie at rest or buoyant a short distance above the bottom to which she was anchored, so to speak, by the weight of the wheels, which were free to move up and down, thus allowing the hull of the vessel to rise and fall without fear of the body of the craft being brought in contact with the bottom. The vertical movement thus permitted was a rise and fall of 3 feet before the keel could reach the bottom. This modification was found to work perfectly, so that it was possible to go out in very rough seas and to navigate in shallow water. With only water enough to barely cover the conning-tower, the submarine would rise and fall with the waves, but to a lesser degree. The diving door was opened when submerged in about 30 feet of water, during a storm so severe that a tugboat accompanying us was compelled to make for the harbor. It has been our uniform practice to lower our wheels when running submerged by the use of the vessel's hydroplanes, while navigating between the surface and the bottom, so that in case of contact with the bottom, the wheels first meet the rock or obstruction. This, in connection with the hydraulic cushioning device fitted to them, has been sufficient to cause the boat to rise above the obstacle without sustaining the slightest injury.

The "Argonaut" at this time was 36 feet in length, with a beam of 9 feet, and was a very stable craft; she was of the usual cigar-shaped type. No restrictions were ever placed upon the movements of the crew while running submerged. After these experiments off the seacoast of Virginia it was decided to take the boat to New York for further tests in the neighborhood of Sandy Hook. About this time we were caught out at night in the severe storm of November, 1898. During this storm nearly 200 vessels were lost on the Atlantic coast, and we found by the severest of practical tests that the cigar-shaped form of vessel was so unseaworthy and sluggish that nearly every sea broke over her hull, burying it several feet deep. The conning-tower of the "Argonaut" was 4 feet in height above the deck, and a platform was erected above this for navigating work when running on the surface. As the night was pitch dark and we were trying to make a harbor in the horseshoe back of Sandy Hook, it was necessary to do the navigating from the outside. The seas became so rough that we were obliged to close down the conning tower hatch, and I was obliged to tie myself to the platform to keep from being swept overboard. We made the harbor about three o'clock in the morning, and, as the weather was freezing cold, the navigator was incased in ice and without a dry thread on his person. This showed the necessity of having greater surface buoyancy, and the need of a larger conning-tower and better means for protecting the navigator against the sweep of heavy seas and rough weather. This brought about the addition of the superstructure and the large navigating conning-tower, which may, to some extent, be a disadvantage so far as speed is concerned, when running submerged, yet its value in handling the vessel in time of storm, and the comfort afforded for navigation at all times when running in a surface condition, more than compensate, in my opinion, for the slight loss of speed.

At the time that the superstructure was added, the "Argonaut" was cut in two and lengthened by 20 feet. The superstructure was built of steel, giving her very much the appearance of an ordinary surface power boat. The fuel-tanks were placed within the superstructure. It was found that the addition of the superstructure gave her a much greater percentage of surface buoyancy, so that she rode the seas, instead of the seas riding over her. Attention was therefore given in later boats to improving the stability when in a submerged condition, as well as attaining greater buoyancy on the surface. In some of our boats we have been able to secure as much as 22 inches between the center of buoyancy and the center of gravity when in a submerged condition.

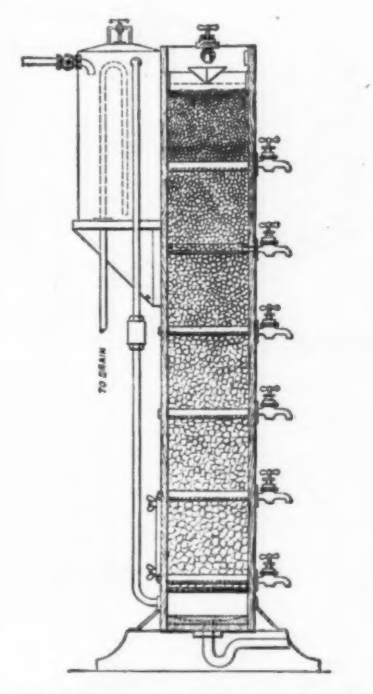
Some of the existing French submarines are 136 feet in length and 9 feet beam, the hulls being practically of spindle form. These are dangerous proportions, and it is hard to understand how the machinery and principal motive weights can be so distributed as to get more than a distance of 9 inches, at most, between the center of buoyancy and the center of gravity of such a long, narrow craft. In the light of my experience, I do not deem it safe to accept a design which will permit of a greater inclination than 10 deg. when the horizontal rudders are set hard down to dive under the maximum power of the propelling machinery. As the maneuvering ability of vessels of the diving type, especially at slow speed, depends upon the vessel's sensitiveness to her diving rudder, it cuts them out of consideration as safe vessels. The greater the stability of the diving type, the less easily they are got under water. As the vessel of the diving type must be inclined in order to dive, it is difficult to have great enough stability to permit of the free movement of the crew in a fore-and-aft direction when the boat is running submerged. Small leaks, or the firing of torpedoes, should not in themselves be sufficient to seriously disturb the trim of the vessel. The experience of the "A 4," of the Royal Navy, in having her trim increased suddenly to 40 deg. by the head, owing to the admission of a moderate quantity of water through one of the ventilators, shows the necessity for greater fore-and-aft stability. The sudden diving of the "Farfadet" and the "A 8" also shows the lack of longitudinal stability in boats of the diving type. The recent disaster to the "Lutin" may be primarily ascribed to lack of longitudinal stability, if the published reports, said to be from sources of official information, be correct. Notwithstanding, we have several times experienced considerable leakage when submerged. On one occasion as much as 6 tons of water worked its way past the valves and into the after ballast-tanks before we were aware of it; we were operating on the bottom at the time. At another time water leaked in through the boat's exhaust valves and filled the cylinder of one of the engines. As the longitudinal stability of the craft was so great, this did not cause any particular inconvenience, and the water was easily handled by our pumps when we discovered the state of affairs. This experience led to the providing of additional safeguards in the form of making all of the ballast-tanks within the boat strong enough to withstand the maximum pressure at the depth to which the boat herself was intended to be submerged. Pipes from the compressed-air system were led to these tanks, so that they might be blown free of water should the valves fail to work properly during the periods of deep submergence. The boat could also be brought to the surface by admitting air to the superstructure.

Submarine vessels are exposed to more danger of collision when running submerged than are surface craft. On surface vessels there are generally two, if not more, persons on the "lookout" for each vessel, and under normal conditions they have the advantage of all-round vision, and the opportunity to check by sound the approach of other craft. The submerged vessel, on the contrary, must avoid all surface craft by the exercise of constant vigilance on the part of the man at the observing instrument. Many submarines are provided with periscopes, which give a view of only a few degrees, and that directly ahead. An early experience impressed strongly upon my mind the danger of accidents from this cause, and led to the attempt on my part to produce an observing instrument which should give an all-round view of the horizon immediately upon rising above the surface. The instrument known as the "Omniscope" was the result of this effort. The omniscope gives an all-round view of the horizon on being rotated in either direction only 30 deg.

Recent experiments have proved the practicability of sending submarines of the non-diving type unseen through narrow, tortuous passages right up to the docks of fortified basins while look-outs were being maintained. The submarine may carry mines and plant them right under the guns of the most powerful forts or ships. The latest method of applying the sighting instrument makes it possible to run the vessel below the surface so that not a ripple is seen, even in smooth water. The sighting instrument, without changing the level and depth of the boat, may be extended above the surface and quickly withdrawn for the purpose of taking an observation. This may be accomplished in less than two seconds. It would probably not be necessary to expose the sighting instrument more than once or twice, for a few seconds' duration while making a submerged attack.

THE TREATMENT OF SEWAGE.

AT a recent meeting of the Royal Sanitary Institute, Mr. W. D. Scott-Moncrieff described an apparatus he has designed for determining the proportions, materials, and construction of sewage filter-beds. The need for such an apparatus has long existed, even if not recognized. In the reports of the Royal Commission on Sewage Disposal, and in other publications, a great deal of information is given upon the construction and performances of resolving tanks; but, as Mr. Scott-Moncrieff points out, no reference has been made to the all-important point as to the best stage of the putrefactive fermentation at which the process should be changed, so as to meet the requirements of the aerobic and oxidizing organisms. To meet this want, the apparatus in question, a sectional view of which we annex, has been designed, and an example of it installed at Staines was lately inspected by a number of engineers and sanitary authorities.



SCOTT-MONCRIEFF APPARATUS FOR TREATING SEWAGE.

The design is extremely simple, the apparatus consisting of a galvanized iron box 8 feet high by 3 feet wide and 1 foot deep. It is filled with a filtering material to a depth of 6 feet. This material may be hard clean coke gaged to pass a ¾-inch mesh, and to be rejected by a ¼-inch mesh. River ballast, broken slag, clinker, gravel, or other materials may be substituted for coke if needed, in order to find out the most suitable medium for the particular description of sewage under test. The coke or other filtering material rests on a perforated plate near the bottom of the box or tank, there being an open space between the plate and the bottom of the tank. At vertical distances of 1 foot there are placed inside the tank, and among the filtering material, gutters or troughs, six in number, which communicate with cocks on the outside of the tank. It will be seen that by means of these troughs samples can be secured of any sewage passing through the filter, and its condition can thus be ascertained after passing through any of the 1-foot zones into which the apparatus is divided by the troughs. In the top of the tank is a horizontal tipping-trough, by means of which the sewage is distributed over the surface of the filtering material. This trough is divided longitudinally by a vertical partition, and it is supported on trunnions at each end. The center of gravity of the trough is above the line of support. The flow of liquid into the trough is suitably regulated, so that the amount delivered in a given time is known. The liquid flows into one side of the trough, until its weight causes the latter to tip over to that side, when the content is spilt, and the other side is brought under the cock, until that, in turn, falls, once more bringing the empty side under the cock. In this way the liquid is poured impartially over a perforated plate, which is above the filter-bed, and an even distribution is secured. In order to regulate the period of tilting, an arrangement is provided for adjusting the degree of departure from stability of the trough by means of weights. For the purpose of aerating the filter an aspirating tank is provided, by which air is drawn through the filtering material.

It is claimed that, by the aid of this apparatus, it is possible to gain information as to the effect of filtration of a definite quantity of a sample of liquid, in a given time, through any filtering material. The sewage of various districts differs materially, and, therefore, needs different treatment. In one case it may be necessary to have a considerable depth of filter-bed, while a filtering medium that may be excellent in one district will be unsuited to another. In the absence of definite knowledge on these and other points, engineers are naturally inclined to allow a wide margin of safety, and when this exceeds that which more certain knowledge would warrant, naturally a waste of money occurs.

As an instance, it may be stated that in the well-known case of the Ashtead experiments the flow was at the rate of one million gallons per acre per 24 hours, and the period of rest between each discharge was 7½ minutes. These conditions were found absolutely necessary to obtain high nitrification, and Mr. Scott-Moncrieff has frequently pointed out the need of ascertaining the two factors mentioned before de-

signing works for dealing with effluent. The quantity of air and depth of filter are two other conditions that must be considered. Surface condition can be varied by the size of materials, and to prevent organic matter accumulating in the interstices a sufficient time must elapse between the discharges, so as to provide for the liquefaction of the organic matter in suspension, in order that no more should pass into the body of the filter than the lower zones can dispose of. This shows the necessity for periods of rest sufficient to prevent accretions of organic matter from clogging the top surface of filter-beds, and 7½ minutes was found sufficient for the purpose at Ashtead. At Staines, Mr. Hall informed Mr. Scott-Moncrieff, it was found that 7 minutes was sufficient in summer; but when, in October, there was considerable discharge from the breweries into the sewers, it was found necessary to increase the periods of rest to 15 minutes.

As another instance of the need for varying the design of filter-beds to meet different conditions of sewage, the case of Hanley may be quoted. Here, we are told, marvelous results were obtained with small particles of filtering material over a period of three years, without interruption of any kind, the sewage being weak in character. When tried at Staines, the same size of material proved worse than useless. Mr. Scott-Moncrieff had advised for Hanley a period of rest of 7½ minutes. It had been suggested—and the proposal had obtained official sanction—that a filter-bed might, apparently, be increased to no less than 12 feet in depth, in the belief that there might be treated a quantity of sewage corresponding to the depth of filter. That, Mr. Scott-Moncrieff pointed out, might possibly be true for filters composed of large materials throughout, including that upon the surface; but, as the proposition ignores surface conditions, it could not possibly be right for the weaker kinds of sewage, with which fine particles give the best results. Pooling of the sewage on the surface would cause a complete upsetting of the whole process, with a probable destruction of the bed in regard to its bacterial activity.

[Concluded from SUPPLEMENT No. 1636, page 26215.]

THE MANUFACTURE, DENATURING, AND THE TECHNICAL AND CHEMICAL UTILIZATION OF ALCOHOL.—II.

By M. KLAR, Chief Chemist of F. H. Meyer, Hannover-Hainholz, Germany.

FROM the foregoing table it will be seen that the manufacture of alcohol, for instance, from corn, comprises the following phases: The cleansing of the raw materials (corn and barley) from dust, dirt, etc., and the storing of the same in suitable lofts and bins. The gelatinization of the corn by steaming under pressure. The production of diastase for the saccharification of the gelatinized starch, by means of green malt prepared from cleansed, steeped, and germinated barley on the malting floor or in the pneumatic malting plant. The production of malt milk from the green malt in suitable apparatus. The production of the fermenting yeast necessary for the fermentation of a portion of the sweet mash in the yeast room. The sterilization and saccharification of the sweet mash in the mashing vats, by means of the malt milk. The fermentation of the saccharified mash by means of an admixture of fermenting yeast in the fermenting vats. The distillation of the alcohol from the fermented mash obtaining the wash at the same time, and the rectification of the spirit.

The raw materials are raised by means of an elevator to the cleansing machine, located above the storing room, where they are freed from dirt, dust, etc., and are then transported by means of a distributing conveyor to the bins or silos, usually constructed of wood and provided with suitable hopper outlets. The granary for the storing of the barley is similar to that used for the corn and is situated above the steeping room and the malting floor.

The first step in the operation of the plant is the production of the malt, as this operation requires from 10 to 25 days according to the character of the malting, either upon the ordinary malting floor or in a pneumatic malting installation. The purpose of the malting is to obtain the ferment called diastase, necessary for the conversion of starch into sugar. The diastase arises from the albumen of the germinating grains.

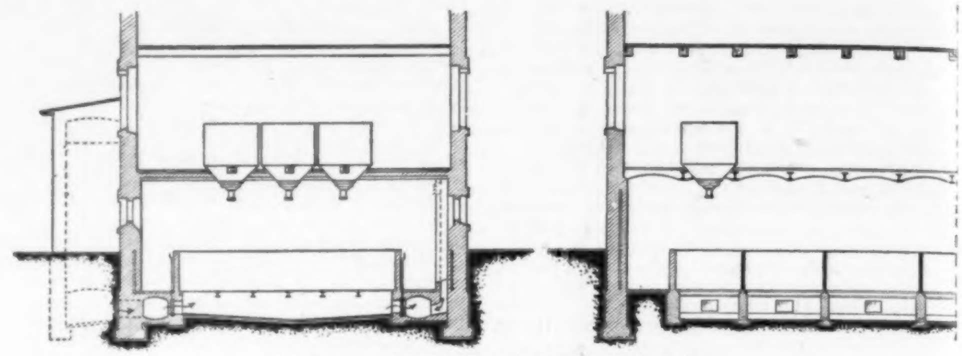


FIG. 5.—A PNEUMATIC MALTING PLANT.

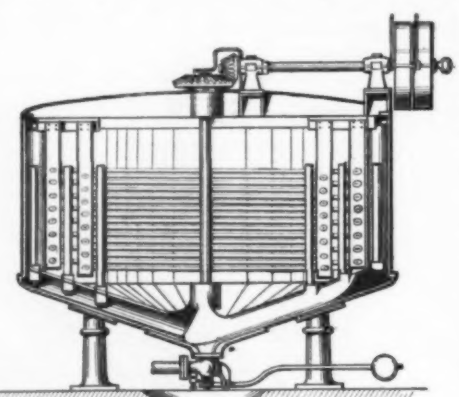


FIG. 4.—MODERN MASHING VAT.

THE MALTING PROCESS.

The cleansed barley is first steeped in special steeping vats constructed either of brickwork or, preferably, of iron. In these vats which, at the same time, permit the cleansing of the grain and the removal of sterile or dead grains, the barley is allowed to remain with the requisite quantity of water for two to three days, according to the temperature. About 40 to 45 per cent of the grains germinate. When the grains begin to germinate they are placed, if the older method is followed, in flat heaps upon the germinating floor, and are from time to time turned with a shovel. The temperature of the grain at various stages of the process serves as a guide, and it should, at no time, be permitted to exceed 63 deg. F. Furthermore, if necessary, the evaporated moisture must be replaced by sprinkling, and provision must be made for the thorough ventilation of the malting floor, as the germinating process is accompanied by the production of carbonic acid, the accumulation of which is injurious to the health of man, and at the same time is prejudicial to the development of the malt.

In germination a portion of the starch of the grains is consumed with the production of carbonic acid and water. Another portion of the starch is converted into maltose. The albumen also undergoes certain changes, being converted partly into soluble albuminous substances, which later serve as nutrients for the yeast, and partly into diastase, the ferment serving for the saccharification of the starch. The malting process with modern methods lasts from 20 to 25 days.

To avoid the long germinating period necessary under the old methods of malting, pneumatic malting has been adopted in late years. In the pneumatic system of malting the thoroughly steeped barley is placed in wide cases constructed of brickwork and having perforated bottoms, preferably of zinc-covered iron. At both sides of each box are channels, one of which communicates with the blower, so that air under compression, saturated with moisture, and at any desired temperature can be forced under the perforated bottom, and after penetrating the germinating grain allowed to escape by means of an outlet there-above. The other channel is connected with another fan, and through it the cold air can be drawn off from the top to the bottom through the germinating grain in order to cool the same.

By means of this apparatus the malting process is

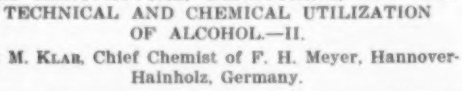


FIG. 1.—GRAIN STEEPING VAT.

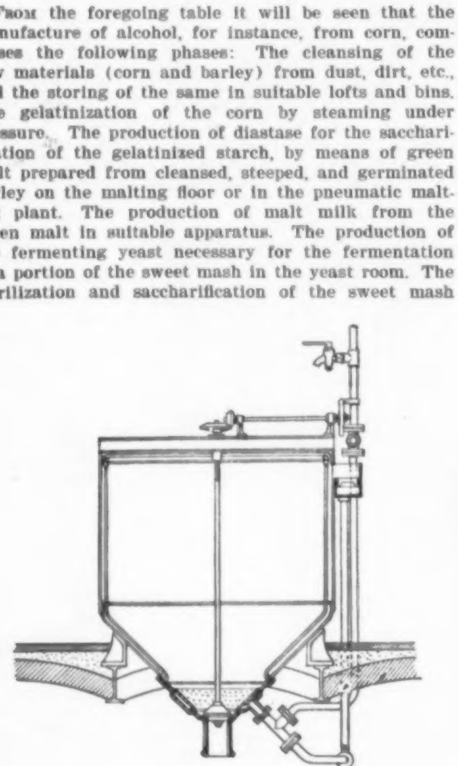


FIG. 2.—GREEN MALT CRUSHER.

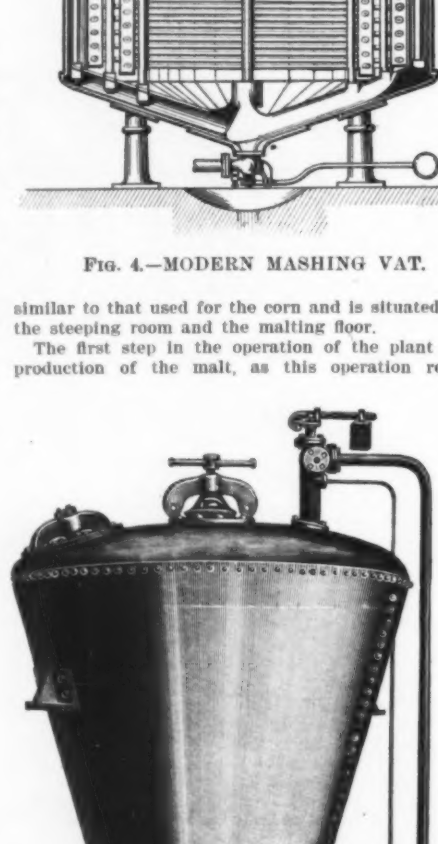


FIG. 3.—MODERN HENZE STEAMING APPARATUS OF CONICAL SHAPE.

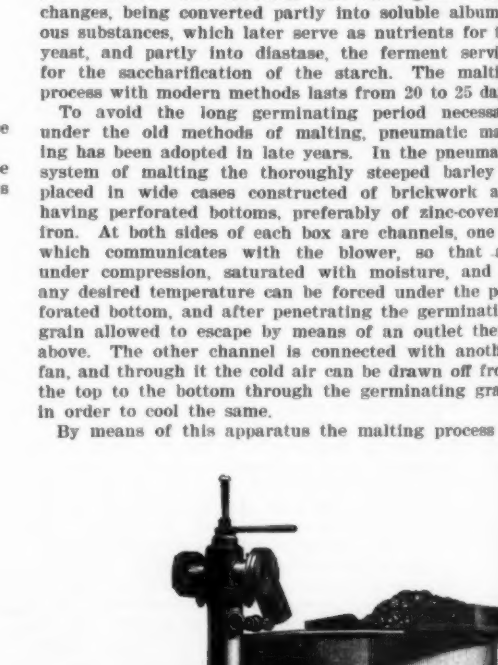


FIG. 6.—MALT MILK APPARATUS OF THE BOHM TYPE.

rendered independent of the temperature of the air, and it is for this reason especially suited for extensive plants, as well as for use in hot countries. Not only is much space saved thereby, but it is also possible to complete the malting process in about ten days, effecting a considerable saving over the older method lasting from 20 to 25 days.

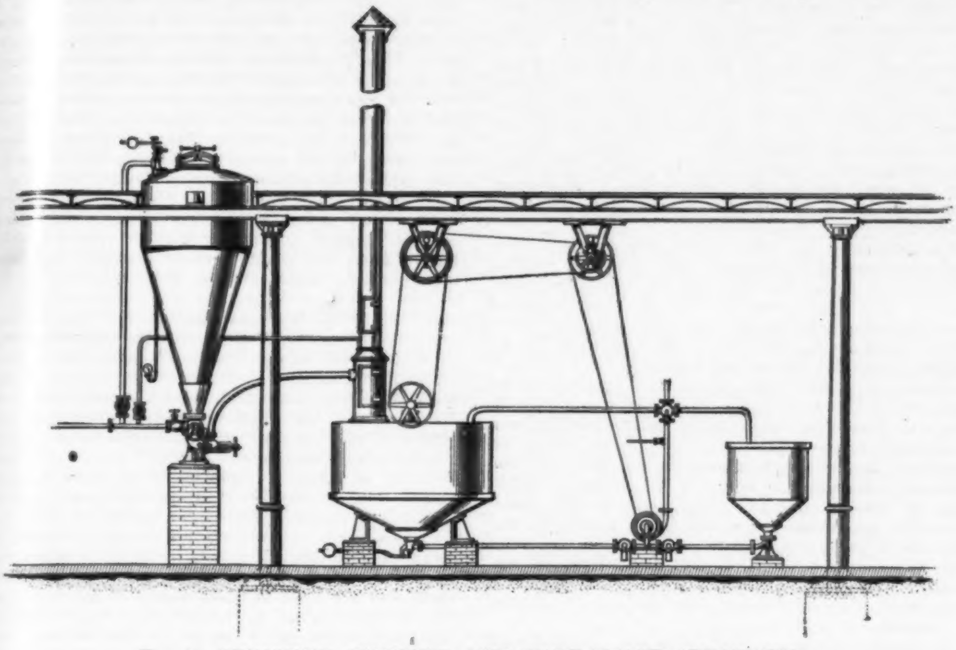


FIG. 7.—STEAMING, MASHING AND MALT YEAST APPARATUS.

From 100 pounds of barley about 145 pounds of so-called green malt are obtained. The green malt, as it contains considerable moisture, cannot be preserved for any length of time, and, therefore, under certain circumstances it is necessary to dry it. The drying process is effected by means of hot air, at a temperature of about 122 deg. F., and it must be conducted with great care in order to insure the preservation uninjured of the diastase. From 100 pounds of barley about 82.5 pounds of dried malt can be obtained. In general, green malt is preferred to dried malt as, despite the greatest care, a certain part of the diastase is almost always rendered ineffective by the drying process.

The green malt as it comes from the malting floor is not in condition to be added to the gelatinized starch. It must first be passed through a malt crushing apparatus, and then turned into malt milk in machinery which emulsifies it with water.

THE GELATINIZATION OF THE RAW MATERIAL.

The anatomical construction of the grains of corn is such that the diastase cannot effectively act upon the starch contained therein until the tissue of the cells is broken down to enable the diastase to come into direct contact with the starch granules. In order to break down the cellular tissue of the grains, it is necessary to steam the corn under a pressure of from three to four atmospheres. The apparatus used for this purpose is known by the name of its original constructor, Henze. The Henze steamer consists substantially of a conical vessel constructed of iron and designed to stand a heavy internal pressure. The larger sizes, and especially the forms used in connection with crushed corn, are provided with agitating or stirring devices. A steamer of the largest size has a capacity of nearly 40 bushels, or about 1,000 gallons. To work 35 tons of corn per day six steamers of this type are necessary, each working one ton or about 40 bushels of corn in each operation of four hours' duration. By means of a suitable elevator the corn is transported from the bin to measuring apparatus, which automatically discharge when one ton has been weighed out. From the measuring apparatus the corn is conveyed to the Henze steamer, into which 315 gallons of hot water have already been introduced for each ton of corn. The steamer is then closed, a small blowoff valve only remaining open. Steam is then introduced through a steam distributing device, and the corn is boiled until it becomes pulpy, the process lasting about an hour. The delivery cock is then regulated so that the boiling continues under a pressure of two to three atmospheres for a further period of an hour. The pressure is finally increased to four atmospheres, the delivery cock being completely closed, and this extreme pressure is maintained for about half an hour. When the boiling or steaming operation is completed, the steamers are emptied into the mashing vats. These have already been partly filled with the malt milk. The steamers are emptied of the gelatinized cornstarch under full pressure, the mass therein being blown out through grates with sharp edges inserted in the blowout pipe to effect a complete maceration of the grains of corn.

SACCHARIFICATION OF THE RAW MATERIAL.

Usually one mashing vat is provided for every two Henze steamers. The vat consists of a closed vessel with a conical bottom, and a suitable inlet opening for the material. Inside of the vat is located a cooling contrivance consisting of oval coils of copper pipe and a powerful agitating device.

In the mashing vat the disintegrated starch is thoroughly mixed with the malt milk, whereby the starch is converted into sugar by means of the diastase. The mash is cooled to the fermenting temperature after the completion of saccharification. If the material from the steamer came directly into contact with the malt milk, the malt would be scalded in part by the excessive heat, whereby the diastase would be rendered ineffectual. For this reason the starchy mass must be cooled before it is introduced into the mashing vat. This is effected in the blowout apparatus of the steamer by the exhauster, which is provided with a suction injector drawing toward the mass, passing

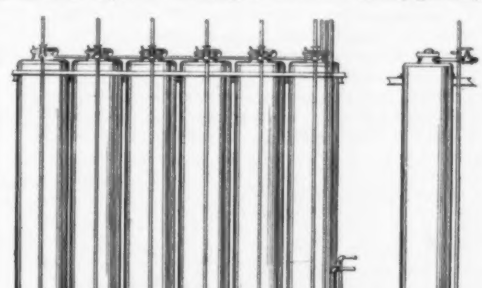


FIG 9.—ALCOHOL FILTER BATTERY.

through the blowout pipe a powerful stream of air; thus the vapors are drawn off, and at the same time the mass itself is cooled.

As the diastase is liable to be injured at temperatures exceeding 149 deg. F., the temperature of the mass must be rapidly brought to a temperature of 122 deg. F. The temperature must then be increased slowly and carefully to 144 deg. F. Toward the end of the saccharifying process the temperature is increased to 126 deg. F. in order to destroy inimical ferments that may be present in the mash. At this stage of the proceeding about one-twelfth of the volume of the sweet mash is taken from the vat to be used in the production of fermenting yeast.

The mash is cooled as quickly as possible, by means of the cooling apparatus within the vat, to 86 deg. F., and an equivalent quantity of fermented yeast is added. The cooling is continued to 66 deg. or 70 deg. F. The entire operation lasts about four hours. When the sweet mash has been cooled to this temperature, it is pumped into the fermenting vats, of which there are eighteen, each containing 8,000 gallons and equal in capacity to three mashing vats and six Henze steamers.

PRODUCTION OF THE YEAST.

The sweet mash taken from the mashing vat is pumped into one of nine vats in the yeast room. It has a concentration of 22 deg. to 24 deg. by saccharometer, and consists largely of maltose. Lactic acid fermentation is now induced, the temperature being kept at 122 deg. to 125 deg. F., as this offers an excellent protection against all organisms inimical to fermentation.

When beginning the operation, in order to excite the lactic acid fermentation, pure cultures of lactic acid bacteria are added to the mash. Later certain quantities of fermenting lactic acid are removed from the vat undergoing normal lactic acid fermentation to serve for the induction of subsequent fermentation. Each yeast fermenting vat contains refrigerating coils which can be agitated to insure thorough cooling, and which can be used for heating purposes by the introduction of hot water or steam therein. After about twenty-four hours the lactic acid fermentation process is completed, and the final step consists in heating the mash to 167 deg. F. to sterilize it. After this it is cooled as rapidly as possible to a temperature of 86 deg. F. A suitable quantity, about one-tenth of the mass contained in the fermenting vat, of mother yeast or pure culture yeast is added. The cooling is continued to 64 deg to 68 deg. F. The fermentation is continued to 4 deg. to 5 deg. by saccharometer, with thorough aeration and agitation of the mass. After the fermentation reaches 4 deg. to 5 deg. saccharometer a quantity of mother yeast is removed for the subsequent yeast production, and the rest is transferred to the fermenting vat already filled with cooled sweet mash.

FERMENTING THE SWEET MASH.

The fermenting vats in a plant of the size we are describing are eighteen in number, each containing about 8,000 gallons. The fermentation lasts about three days and consists of three phases: 1. Prefermentation, consisting principally in the formation of yeast in the mash necessary for the second phase. 2. Chief fermentation, the conversion of the maltose present into alcohol and carbonic acid. 3. After-fermentation, in which the diastase acts upon the dextrin present, saccharizing and fermenting it.

The fermenting vats, like the yeast vats, are provided with movable coils, by means of which cold or hot water or steam as required can be circulated in the fermenting mass. By the movement of the coils the fermenting mass can be thoroughly aerated to permit the necessary escape of the carbonic acid, which must be removed from the room by proper ventilation. During pre-fermentation the temperature of the fermenting mass should be kept at about 66 deg. to 70 deg. F., during chief fermentation at 82 deg. to 86 deg. F., and during after-fermentation at about 79 deg. to 82 deg. F. The fermentation itself is considered at an end when the saccharometer reading has fallen from about 22 deg. to 1½ deg.

PRODUCTION OF ALCOHOL FROM THE MASH.

From the schematic outline above, it appears that

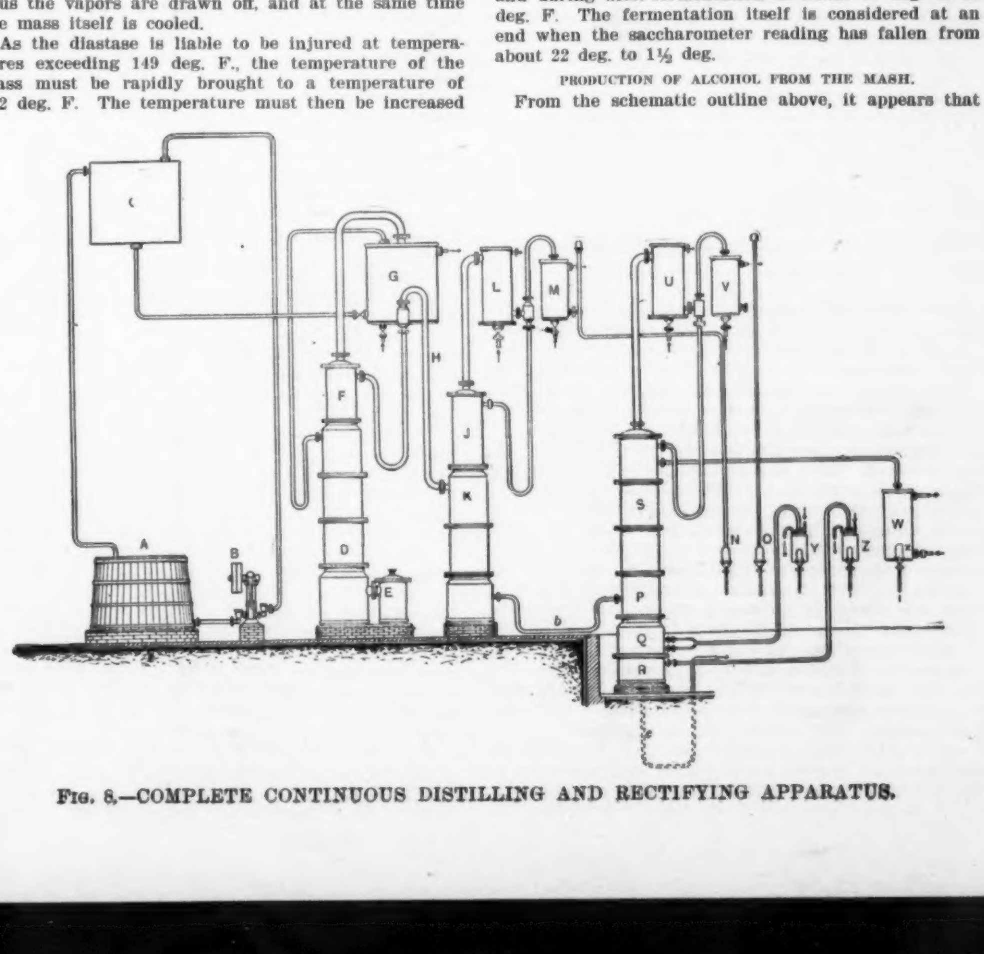


FIG. 8.—COMPLETE CONTINUOUS DISTILLING AND RECTIFYING APPARATUS.

the fermenting process yields per ton 1,100 gallons of fermented liquid of 1 deg. to 1½ deg. by saccharometer, and containing the volatile products, as well as the unchanged non-volatile constituents of the mash and the yeast. The constitution of the fermented mash is as follows:

	Per cent.
Mineral substances	0.6
Nitrogenous substances	2.4
Fibers	1.2
Extractive substances	5.8
Fat	1.0
Alcohol and by-products	9.0
Water	80.0

To remove in a concentrated form the alcohol contained in the fermented mash, the latter is subjected to repeated distillation, leaving the wash as a residue. The distilling process is based upon the difference between the boiling points of water, alcohol, and the by-products. The boiling point of water is 212 deg. F., and of alcohol 174.2 deg. F.

Distilling apparatus is based upon the principle that in bringing an alcoholic liquid to the boiling point, the vapors which rise therefrom, in consequence of their lower boiling points, contain more alcohol proportionately than the original liquid. Thus, a solution of alcohol of 10 per cent returns a 50 per cent distillate, and the 50 per cent solution in turn a distillate of 88 per cent; the latter finally returns a distillate of 92 per cent by weight, or 94 per cent by volume. Thus, in order to obtain from a 9 or 10 per cent mash 94 per cent spirit by means of an ordinary still and cooler, four or five distilling operations are necessary. It is obvious that this is neither a simple nor easy method of operation. Modern apparatus does away entirely with repeated distillation, the apparatus being continuous. The vapors pass through several stills, as it were; the vapor entering the first still, and containing the greater part of the alcohol, is condensed to a hot liquid and revaporized, the process being repeated in the subsequent stills. In this way the process consists of repeated vaporizations and condensations, the number depending upon the number of stills, and from the last of these the concentrated spirit is withdrawn. The column distilling apparatus is similar in principle, consisting essentially of a plurality of stills as described above. The contrivances within the column apparatus are equivalent to a great many stills placed one above the other, and provided with overflow outlets from one to the next below. The advantage presented by this system is that there is no necessity for having a particular cooler for each still in order to condense the rising vapor for the purpose of renewed vaporization. In the column apparatus a single common cooler is placed above the last still, and delivers the pure concentrated alcohol. This cooler or rather concentrator effects the cooling of the distillate from the last of the stills; and while only a relatively small portion is received from the cooler in a condition for use, the remainder or greater portion, at a relatively low temperature, returns to the column for redistillation. In the latter the vapor is condensed in rising from chamber to chamber by the already condensed liquid therein, and in passing from chamber to chamber is materially strengthened, merely by coming into contact on its way through the column with the concentrated liquids passing in the opposite direction.

According to the construction of the apparatus with this type of still, it is possible to obtain 92 to 93 volume per cent spirit containing 0.3 to 0.5 per cent of fusel oil, or even chemically pure 96 volume per cent alcohol from an alcoholic liquid of any concentration. In these stills the operation is continuous, and any source of heat can be utilized.

	Color.	Reaction.	Volume Per Cent of Alcohol	Per Cent Fusel Oil
Raw Spirit........	Colorless or Slightly Yellowish.	Neutral.	87 to 93	0.2 to 0.6
Refined spirit or pure alcohol...	Colorless.	Neutral.	96.2	None.

The choice of the distilling apparatus depends upon whether raw spirit or pure alcohol is to be manufactured. If the plant is a small one, the manufacture of raw spirit only is generally undertaken therein. This raw spirit is either sold directly for denaturation, or goes to special refineries, where it is purified through the removal of the fusel oil.

During late years the construction of distilling apparatus and plants has been so perfected, that it is possible to obtain in a single operation pure alcohol in no way inferior to the spirit obtained by two or more operations with periodically working apparatus. In this country if it is desired to manufacture alcohol under the new tax-free alcohol law for purposes of denaturation, a plant utilizing 40 or more tons of corn per day should by no means content itself with the production of raw spirit. Even in smaller plants the manufacture of pure alcohol by means of the perfected apparatus obtainable will be of great advantage. Primarily, the cost is not much greater than that of manufacturing raw spirit, and the advantages in regard to salability, higher price, etc., are manifest.

Among the accompanying illustrations is an example of the latest type of apparatus for the distillation of pure alcohol directly from the mash—a continuous still manufactured by F. H. Meyer, Germany. The fermented mash is raised by the mash pump from the reservoir *A* to the distributing reservoir *C*, provided with an overflow to *A* for the purpose of maintaining a constant level. The mash, serving as cooling means, enters the cooling apparatus of the column *F D*, and from there in a preheated condition through the siphon tube into the lower column *D*. Here the volatile constituents are concentrated to about 50 per cent, part being cooled and returned from *G* to *F* to continue the rectification. A concentrated portion goes to *H*, where it is condensed and introduced in a heated condition into the upper part of the column *K*. The volatile constituents, such as aldehyde, accumulate in the upper column *J*, and by the effect of the cooler, the main part of the vapors containing aldehyde from *J* are continuously returned to *J* for renewed rectification, an equal part of the vapors arising from *J* being condensed by *M* and withdrawn through the sight glass.

The remaining hot spirit, freed from the more volatile by-product but charged with the less volatile constituents, passes through the pipe *b* into the lower part *P* of the third column *S P Q R*, encountering steam entering from below. Here the final separation of the by-products is effected in the section *Q*, the resulting distillates flowing continuously to the cooler *J*, and being withdrawn there in the form of concentrated fusel oil. The spirit vapors thus freed from fusel oil, but still containing other more volatile constituents, accumulate in the column *S*. The portions which accumulate in the three uppermost sections are continuously eliminated by means of the coolers *U* and *V*, and are finally removed. The purest alcohol comes from the apparatus below the three uppermost sections of *S*, and is removed by the pure alcohol cooler *W*. The cooler *Z* is merely for the purpose of controlling the steam introduced into *R* and removing condensed steam as spindlings by the pipe *C*, no alcohol passing off with it.

Distilling apparatus of this type are provided with easily visible control ing devices as well as automatic regulators for all the inlets and outlets. But one man is necessary for its operation, and when the apparatus is once put in operation it will continuously produce pure alcohol from the mash directly, with practically no supervision. Apparatus of this character is, of course, expensive, but in view of the great advantages it presents, and the economies possible by means of it, the investment is a sound one. When the alcohol produced is intended for internal consumption, the product is, of course, filtered over charcoal after dilution.

[Continued from SUPPLEMENT No. 1636, page 26219.]

THE INFLUENCE OF PHYSICAL CONDITIONS IN THE GENESIS OF SPECIES.*

By JOEL A. ALLEN.

As already stated, geographical variation in color may be conveniently considered under two heads. While the variation with latitude consists mainly in a nearly uniform increase in one direction, the variation observed in passing from the Atlantic coast westward is more complex. In either case, however, the variation results primarily from nearly the same causes, which are obviously climatic, and depend mainly upon the relative humidity or the hygrometric conditions of the different climatal areas of the continent. In respect to the first, or latitudinal variation, the tendency is always toward an increase in intensity of coloration southward. Not only do the primary colors become deepened in this direction, but dusky and blackish tints become stronger or more intense, iridescent hues become more lustrous, and dark markings, as spots and streaks or transverse bars, acquire greater area. Conversely, white or light markings become more restricted. In passing westward a general and gradual blanching of the colors is met with on leaving the wooded regions east of the Mississippi, the loss of color increasing with the increasing aridity of the climate and the absence of forests, the greatest pallor occurring over the almost rainless and semidesert regions of the Great Basin and Colorado Desert. On the Pacific slope north of California the color again increases, with a tendency to heavy, somber tints over the rainy, heavily-wooded region of the northwest coast.

Geographical variation in color among mammals, for reasons already stated, is generally, but not always, manifested merely through the varying intensity or depth of the tints. It is, however, often strongly marked. The common chickaree, or red squirrel (*Sciurus hudsonius*), for example, which ranges from high northern latitudes southward over the northern portion of the United States, shows an increase in the color over the middle of the dorsal surface from pale yellowish or fulvous to rufous. The fox squirrel of the Mississippi Valley (*Sciurus niger, ludovicianus*), which ranges from Dakota southward to the Gulf of Mexico, has the lower parts, at the northward, very pale yellowish white, which tint gradually increases in intensity southward till in Louisiana it becomes deep reddish orange, the dorsal surface also becoming at the same time somewhat darker. Excepting the fox squirrels and a Pacific coast variety of the chickaree, all the squirrels living north of Mexico have the lower parts white, while those inhabiting tropical America have the lower parts fulvous, deep golden, orange, or even dark brownish red, specimens with the belly white being exceptional, though occasionally occurring in several of the species.

Mammals tend strongly to run into melanitic phases, which are especially developed at particular localities or over limited regions, but whether or not the result of geographical influences is not clearly evident. The whitening of the pelage in winter at the north in a considerable number of species of mammals and in one genus of birds, and not elsewhere, is, on the contrary, a strictly geographical phenomenon, but seems to be the result of other than the ordinary causes of geographical variation in color. Its occurrence in some species and its absence in others closely allied to them is a fact not readily explained. It shows, however, how differently different animals are affected by the same influences. The change to a white winter livery is more complete in the higher latitudes, where the whiteness pervades the pelage to a greater depth and continues for a longer period, the change being only partial in the southern representatives of species that exhibit this seasonal change of color.

In respect to southward increase in color among birds, a few examples only out of the many almost equally striking can be here given. These will be chosen from widely different groups and will represent localities remotely separated, as well as very diverse styles of coloration. In comparing, for instance, New England examples of the common quail with others from southern Florida the colors are found to be so much stronger and darker in the southern birds as to give the appearance of their being entirely distinct species, particularly when the smaller size and larger bills of the southern race are also considered. While in the northern birds the color of the dorsal surface is gray and rufous, slightly varied with black, the gray is wholly wanting in the southern type, the rufous is much stronger, and the black markings are very much broader. The lower surface is varied by transverse bars of black and white, but while in the northern birds the white bars are twice, or more than twice, the width of the black ones, in the southern birds they are often of equal width; or the black bars may be the broader, with much more black bordering the white throat patch, giving, on the whole, a very much darker aspect to this region of the body. Yet when a series is brought together from many intermediate localities, there is found to be a complete intergradation between the most extreme phases. In the common towhee the style of coloration is entirely different from that seen in the quail, the colors being chiefly massed in large areas, with white markings on the wings and large white spots at the ends of the outer tail feathers. In this species southern specimens differ from northern ones in the black of the upper parts and the chestnut of the sides being more intense, while the white markings on the wings and tail are greatly reduced in area. In the northern bird, four of the outer pairs of tail feathers have a large white spot near the end, while in the southern form only three pairs are thus marked.

In the purple grackle the plumage (in the males) is everywhere black, with, at the north, greenish or bronzy reflections; in the southern or Floridan form the black is more intense, and the reflections are steel blue and purple, with iridescent bars across the middle and lower parts of the back. In the northern form the female is dull brownish-black, with little or no iridescence, while in the southern form the female is nearly as lustrous as the northern male. The two types differ so widely, not only in color, but, as previously noticed, in size and in the form of the bill, that, without the connecting specimens from intermediate localities, no ornithologist would hesitate to regard them as entirely distinct species; and they were, indeed, at one time so regarded. The red-winged blackbird has, excepting its red wing patches, also a lustrous black plumage throughout, and presents a similar range of variation in general color with the preceding; while the red of the wing patch becomes much darker at the southward, and its creamy-white border seen in the northern form changes to yellowish-orange in the southern.

The common blue jay, and the long-crested jays of the Rocky Mountain region, may be cited as illustrations of southward increase in brilliancy or intensity of coloring where the prevailing tint is blue; the green Mexican and Rio Grande jays of a passage from yellowish-green tints into bright yellow; the yellow-throated warblers (genus *Geothlypis*), several of the flycatchers (genera *Myiarchus* and *Tyrannus*), and the meadow lark, as examples of increase in the area and intensity of yellow; several of the woodpeckers (genera *Centurus* and *Sphyrapicus*), the cardinal finches (genus *Cardinalis*), and some of the tanagers (genus *Pyranga*), of a similar increase of red; the goldfinches (genus *Chrysomtris*), and most of the species above named, of increase in extent and purity of black areas. The Rocky Mountain jays have, at the northward, a large portion of the plumage rather dark ashen, which farther southward becomes bluish ash, and still farther south culminates, in the Central American States, in blue. In the genus *Geothlypis*, the Maryland yellowthroat (*G. triches*), which ranges over the whole United States, and thence far southward, has at the northward the abdomen whitish; more to the southward, yellowish; and, in the West Indies, Mexico, and northern South America, runs into races in which the abdomen is bright yellow. At the same time the black markings about the head increase in extent and purity and the general size becomes larger, the group having its metropolis in the tropical regions. In consequence of these variations in color and size this species at the southward becomes differentiated into several more or less well-marked subspecies (formally accorded full specific rank), which are connected by an unbroken series of intergradations.

In the great-crested flycatcher (*Myiarchus crinitus*)

* Reprinted, with note and bracketed additions by the author, from the Smithsonian Institution's Report.

of the United States the yellow of the abdominal region is much the stronger in the southern birds, while the same is true of several of the western species of the same genus, which at the southward also pass into several recognizable subspecies.

The western goldfinch (*Chrysomitris psaltria*) affords a well-known instance of increase of black. This species is found in the western half of North America from about the parallel of 40 deg. southward to Ecuador. The northern form has the black of the upper parts mainly restricted to the head, wing, and tail, the rest of the dorsal surface being olive green. In northern Mexico the back begins to be more or less clouded with black, which tint increases in extent in Central America till it wholly replaces the olive green, while in northern South America it becomes more intense and lustrous. In northern specimens the tail is marked with white spots, which either decrease greatly in size or become wholly obsolete in the southern races. The extremes, as may well be imagined, are widely diverse in their coloration and, though formally regarded as entirely distinct species, have been found so thoroughly to intergrade that it is impossible to draw any lines of separation between the several races. Lawrence's flycatcher (*Myiarchus lawrencei*) affords also a striking example of southward increase in the area and intensity of black. At the northward this species has a grayish-black crown, which gradually passes southward into a form with the crown wholly deep black. With the increase southward of the area and intensity of black markings there is also in this, as in other species, a general increase in the intensity or depth of the other accompanying tints.

The red-bellied, or Carolina, woodpecker (*Centurus carolinus*), a common bird of the United States, shows a strong increase of red on the head and lower surface of the body at the southward, in which this tint is not only much brighter, but also much more extended in the south Florida birds than in those from the Northern States. At the same time it presents, in common with other species of the same family, a marked southward decrease in the size of the white transverse bars and spots of the dorsal plumage.

In the southern portion of the Mississippi Valley the variation is in a tropical direction, and is merely due to the more northward extension there of tropical influences. In passing to the plains and the Great Basin west of the Rocky Mountains, however, an entirely different phase of color variation is met with. Here, as a general rule, there is a loss of color, this region being characterized by the presence of subdued or faded tints in the representatives of species having a nearly continental range. The transition, however, is as gradual as is that of the climatic conditions, the paleness beginning near the eastern border of the Great Plains and increasing westward, reaching its extreme phase in the arid wastes of the almost wholly rainless districts of the far Southwest—south Nevada, Arizona, and the contiguous region westward and southward. In respect to this part of the subject it is hardly necessary to say more than that the representatives of continental species found here are uniformly much paler than those inhabiting the adjoining regions; that in many cases the paler forms were originally described as distinct species, and are commonly recognized as varietally distinct, though found to inseparably intergrade with the neighboring darker forms. In addition to the general paleness, there is often an increase in the areas of white and in some cases an accession of new ones.

The wooded, mountainous districts embraced in this region also give rise to peculiar local phases of color variation, to give a detailed account of which would too greatly extend the present paper. The tendency is mainly toward the development of more or less well-marked rufous or fulvous phases of coloration, with sometimes an accession of red, while not a few species have more than the usual amount of black. A most striking instance of increase of red at western localities is seen in the yellow-bellied woodpecker (*Sphyrapicus varius*)* which, in some of its forms, ranges in the breeding season over the more northern and elevated wooded portions of the continent. In its eastern form the male has merely the chin, throat, and crown red, while in the female the red is restricted to the crown. In rare instances there is a trace also of a narrow red nuchal band. In the Rocky Mountain form, however, there is always a red nuchal band, the red on the throat is more extended in the male, and a small area of red appears also on the throat of the female. In the form met with in the Cascade Range the red begins to spread over contiguous portions of the plumage, while in the form occurring along the Pacific coast the red overspreads the whole head, neck, and breast, through which, however, the markings of the eastern birds can generally be readily traced. Here we have, at one end of the series, the red confined to a few distinct patches about the head, while at the other it extends over the whole anterior half of the body. Yet the intergradation between the two has been so fully traced that these diverse forms are now held by competent authorities as merely local races of a single species.

Another case of the increase of red over the same region is afforded by the golden-winged and red-shafted woodpeckers (genus *Colaptes*), in which yellow in the eastern form is replaced by red in the other; in the middle region of the continent the species being largely represented by individuals in which are variously combined the special characteristics of the two forms. In the present case the black cheek patch of the eastern form is replaced by a red one in the western. Traces of the characteristics of the western type occasionally appear in the most eastern representatives of the eastern type, and, conversely, features of the eastern bird appear in the most western representatives of the western, showing at least their close affinity and probably community of origin.

The Pacific coast region from California northward is characterized by a great accession of color, all the continental species being here represented by forms much darker even than on the Atlantic coast. Here the coloration is duller than at the southward, though perhaps equally strong, the general tendency being to fuscous or dusky tints. We consequently find among the mammals and birds of the United States three strongly marked phases of color differentiation among representatives of the same species, characterizing the three most strongly-marked climatal regions—a bright, strongly-colored form east of the Great Plains, a pallid form over the dry central region, and a deeply colored fuscous form over the rainy, heavily-wooded region of the northwest coast. Examples of this differentiation are afforded by apparently all the species whose habitats extend entirely across the continent, the several local forms being in some species only more strongly marked than in others. Among mammals illustrations are afforded by different species of squirrels, hares, mice, lynxes, deer, etc., and among birds by six or eight species of sparrows, a number of woodpeckers, several flycatchers, thrushes, and warblers, the meadow lark, various hawks, owls, etc. Generally these several geographical forms were originally described as distinct species, and many of them are still thought worthy of recognition by varietal names. As intermediate links began to be discovered they were at first looked upon as the result of hybridity between the supposed distinct species whose characters they respectively combined, but eventually such links were found to be too frequent and too general over the areas where the habitats of the several forms come together to render such a supposition longer tenable, it finally appearing that they were only the connecting forms between merely local races or incipient species.

The local races of any given region, as compared collectively with those of contiguous regions and the manner of their mutual intergradation, point plainly to some general or widely acting cause of differentiation. This is indicated by the constancy of the results, so many species, belonging to numerous and widely distinct groups, being similarly affected. Will the fortuitous, spontaneous results of natural selection yield a satisfactory explanation of these phenomena, or must we seek some more uniform and definitely acting cause? To briefly summarize the results above detailed, we have a somewhat uniform increase of size in some given direction, affecting many species simultaneously and similarly over the same areas. We have a frequent enlargement of peripheral parts, affecting not a few, but many, species, and all in a similar manner, though in varying degrees. We have a very general increase in the depth or intensity of colors southward, a general loss of color in approaching the central arid portions of the continent, and again an excessive increment of color under still different climatic conditions and over a different area. We find the increase of size among the individuals of any given species to be quite uniformly in the direction of the center of distribution of the group to which the species belongs, this being especially well marked in mammals. We find the increase in the size of peripheral parts, as the external ear and the length of the pelage in mammals and the size of the bill and length of the tail in birds, to be in the direction of the regions where these parts meet, respectively, their greatest development—the increase in color (especially among birds) toward the region where are developed the richest and most lustrous tints; the loss of color in the direction of the region where the greatest general pallor prevails.

We find again that the enlargement of peripheral parts correlates with increase of temperature; the southward increase of color with an increase of atmospheric humidity and temperature, and consequently with the protective influences of luxuriant arboreal vegetation and clouds; and, conversely, the loss of color accompanying excessive aridity, a scanty vegetation, and an almost cloudless sky, the conditions, in short, of all others the most powerfully effective in the blanching of color; and again, the somber, dusky, tints of the northwest coast accompanying the most humid conditions of climate and the conditions generally most favorable for the protection or preservation of color. Are these merely accidental coincidences, or are they the evident results of cause and effect? Because the white winter livery of some of the northern species is more protective against cold than darker tints would be, or aids in concealing them in some cases (as in the hares and ptarmigans) from their enemies, or in other cases (as in the ermines and the arctic fox) tends to aid them in stealing unperceived upon their prey, are they to be regarded as unquestionably the beneficial results of the working of natural selection? Because the dull gray tints of species inhabiting the semiarid regions of the interior harmonize well with the general gray aspect of their surroundings, is this concordance the result again of the operation of the law of natural selection, the less favorably colored having been weeded out in the struggle for existence? Are the heavy, dull colors of the humid region of the Northwest the result, again, of the necessary influence of natural selection in perpetuating only the individuals whose colors best accord with their somber conditions of environment? Has the same action brought about the bright, rich coloration of birds, insects, and other animals under the warm, humid conditions of the hotter parts of the earth, preserving the ratio of brilliancy of coloration with that of the conditions that everywhere most favor such differentiation? Finally, is the exact correlation of the changes in coloration with the gradual change of climatic conditions in passing from one geographical region to another the result in like manner of the long-continued weeding out of the less favored? Or are these modifications severally due to the *direct* action of the conditions of environment?

In answering these questions it may be well to glance first at the nature of the theoretical origin of differentiation through the influence of natural selection as expounded by the leading advocates of the theory. As is well known, all the individuals of a species found at the same locality (differences resulting from sex and age aside) are not all cast in the same mold, but differ constantly, the average range of purely individual variation in general size and in the size of different parts ranging (in birds and mammals) from 8 to 15 or 20 per cent of the average size for the species, with a corresponding amount of variation in color. These variations are found to tend in every conceivable direction, and it of course follows that some of them must be in directions exceptionally favorable to the species. The theory of modification by the action of natural selection only supposes that the stronger or otherwise more favored individuals transmit their favorable qualities to their offspring, and that the latter, in consequence of their inherited advantages, multiply more rapidly than their less favored relatives; that these favorable deviations from the parental stock become in subsequent generations more pronounced, and that the original form is eventually overpowered and supplanted by its modified descendants. From the same original stock may be conceived to arise, even simultaneously, other forms diverging in different, though still favorable, directions, these in turn giving rise to several lines of descent, occupying perhaps different portions of the habitat of the original species, where they also multiply and become dominant, and eventually pass on from the stage of incipient species to more or less widely differentiated types. These premises being admitted—and they are certainly within the bounds of reasonable conception—only the element of time apparently is requisite for the development of an endless variety of unstable forms, constantly increasing in number and following divergent lines of development, and thus capable apparently of giving rise to all the diversity of organisms at present peopling the earth.

But there are many adverse circumstances with which the favored forms have in the outset to contend and to which in the majority of instances they must succumb. These are, first, the minuteness of the first favorable divergence, the isolation of the individuals in which it appears, and consequently the impossibility of such individuals pairing with others similarly favored, and the consequent tendency of the offspring to possess the favorable characters in a less rather than in a greater degree than the parent, and to be absorbed into the original stock. Secondly, in case the incipient advantages are perpetuated, as it is necessary to suppose, the new offshoot must originate from a single point and spread thence gradually to contiguous regions as its representatives slowly multiply.

But it is supposed, again, that new forms are not always thus gradually evolved from minute beginnings, but sometimes—perhaps not infrequently—arise by a *saltus;* that individuals may be born widely different from their parents, differing so widely and persistently as not to be so readily absorbed by the parental stock. In proof of this, instances are cited of new species apparently appearing suddenly and of varieties thus originating under artificial conditions resulting from domestication. Granting that new forms may thus arise, although as yet few facts have been adduced in its support, they are necessarily at first local and in no way accord with the observed geographical differences that characterize particular regions and which affect similarly many species belonging to widely different groups.

(To be continued.)

IMPROVEMENT IN QUADRUPLEX TELEGRAPHY.

DIRECT-CURRENT dynamos are usually employed for the generation of power for the operation of telegraph circuits, including duplexed and quadruplexed lines. For many reasons it would be advantageous to utilize alternating currents for quadruplex work, but difficulties have been encountered in this direction that are absent when using direct currents. In the endeavor to adapt alternating currents to multiplex telegraphy, the problem has been to avoid interference and mutilation of signals, when more than one circuit is supplied by one machine and the instruments of different circuits are working simultaneously. Mr. J. C. Barclay, assistant general manager and electrical engineer of the Western Union Telegraph Company, has been granted a patent on a method of operating as many circuits as may be convenient from one machine, without any interference between them. He uses as many commutating rings on the armature shaft as there are circuits to be operated. Each ring is divided into conductive and non-conductive sections, two of each. The two conductive arcs are connected electrically, while the non-conductive arcs are dead. The brushes are so disposed in their relations to the insulated and conductive sections of the rings that one collects the positive currents and the other the negative. The positive current is used in operating one side of the quadruplex and the negative the

* In 1877 *Sphyrapicus varius* included *S. ruber* as one of its subspecies, now generally held to be a distinct species.—Author's note, 1906.

other side, the corresponding receiving relays being so wound that one responds only to positive currents and the other to negative. When two or more circuits are connected to one machine the commutating rings are so arranged on the shaft that no two circuits receive current pulsations at the same instant—that is, the positive pulsations, for instance, do not begin and end simultaneously. The lag is sufficient to allow a pulsation on one circuit to die out before the pulsation of the same sign passes into another circuit. Thus the pulsations of each sign follow one another in such rapid succession that even a dot of the Morse code will include enough of the corresponding positive or negative pulsation to cause the operation of the corresponding polarized relay at the distant station without a break. It is evident from this that the pulsations go to the different circuits at different instants, and in consequence there can be no interference between the circuits.—Electrical World.

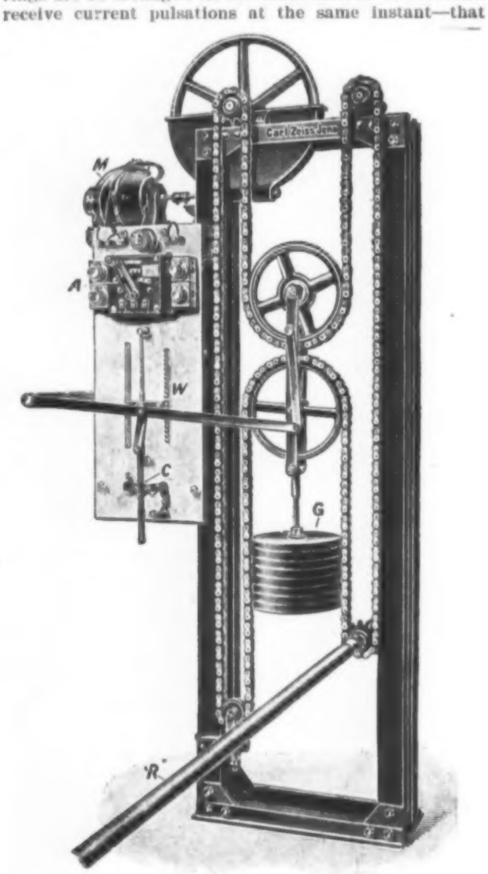


FIG. 1.—THE WEIGHT AND THE ELECTRIC MOTOR FOR ELEVATING IT WHEN IT HAS REACHED THE LOWERMOST POSITION.

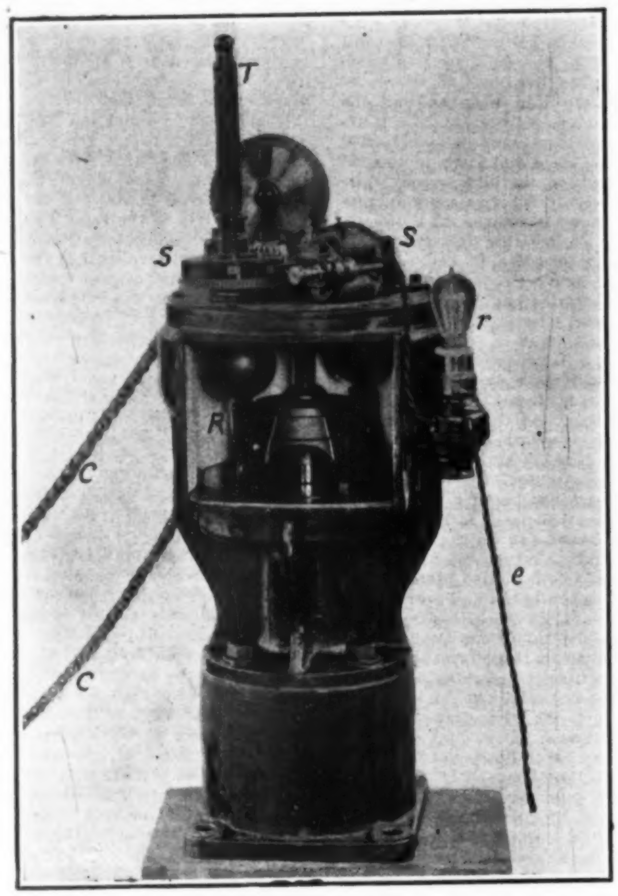


FIG. 2.—FRICTION SPRING REGULATOR AND ELECTRIC SECONDS; CHECKING DEVICE FOR REGULATING THE MOTION OF THE HOUR AXIS.

ELECTRICALLY OPERATED EQUATORIAL MOUNTINGS FOR TELESCOPES.

By Our Berlin Correspondent.

The construction of telescope mountings has become a most complicated problem since the introduction of photography as an auxiliary to visual observation, the more so as the light-gathering power and dimensions of astronomical instruments have been in-

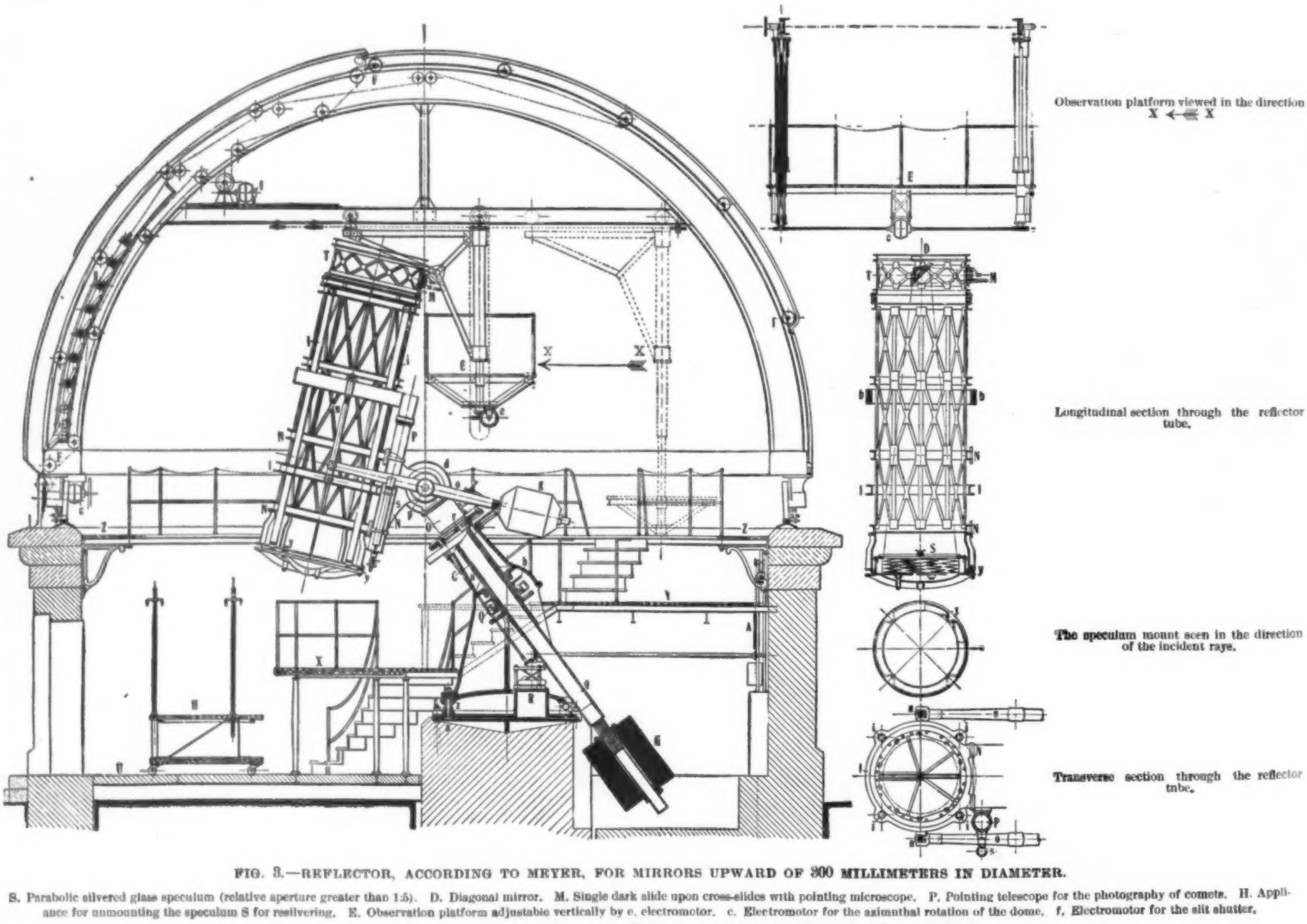


FIG. 3.—REFLECTOR, ACCORDING TO MEYER, FOR MIRRORS UPWARD OF 300 MILLIMETERS IN DIAMETER.

S. Parabolic silvered glass speculum (relative aperture greater than 1:5). D. Diagonal mirror. M. Single dark slide upon cross-slides with pointing microscope. P. Pointing telescope for the photography of comets. H. Appliance for unmounting the speculum S for resilvering. E. Observation platform adjustable vertically by e, electromotor. c. Electromotor for the azimuthal rotation of the dome. f. Electromotor for the slit shutter.

ELECTRICALLY OPERATED EQUATORIAL MOUNTINGS FOR TELESCOPES.

creased of late years. It should be remembered that astronomical telescopes are mounted on two axes perpendicular to each other, so that any spot in the sky can be covered. These axes should be so adjusted that one (the hour axis) lies parallel to the axis of the earth. A telescope mounting thus designed is called parallactic. Both right ascension and declination (that is, the data by which the location of any given spot is defined) are gaged by means of scales. After once adjusting the telescope, it will be sufficient in order to observe a star for any length of time, to turn the instrument around the hour axis.

The conditions imposed upon the construction of parallactic telescope mountings are so many that none of the systems so far developed is able to comply with all of them. However, the construction recently invented by Herr F. Meyer, assistant of Carl Zeiss at

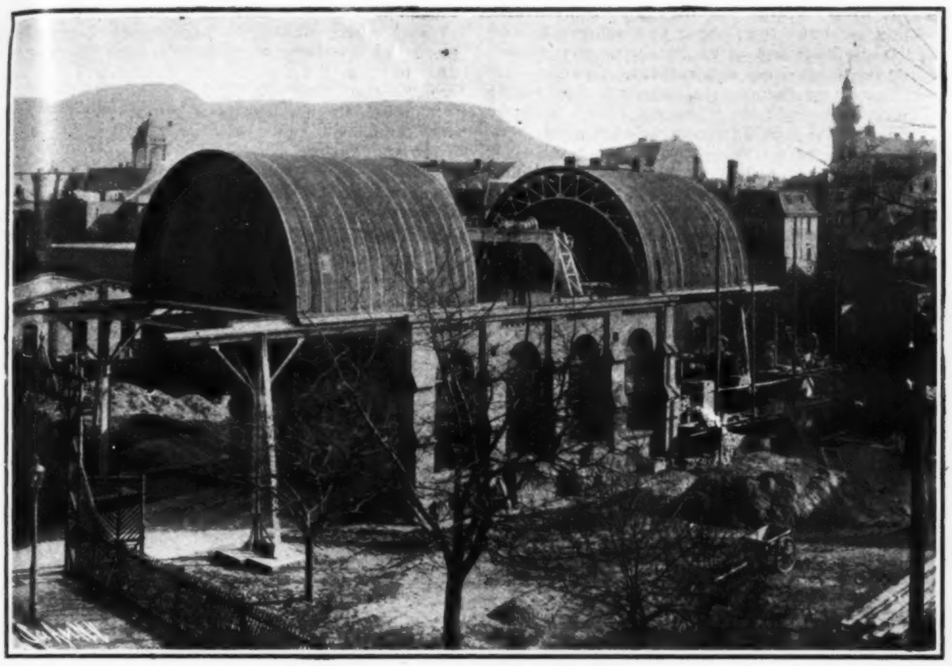


FIG. 4.—ERECTING SHOP FOR ASTRONOMICAL INSTRUMENTS. THE ROOF MAY BE REMOVED IN ORDER TO TEST LARGE TELESCOPES.

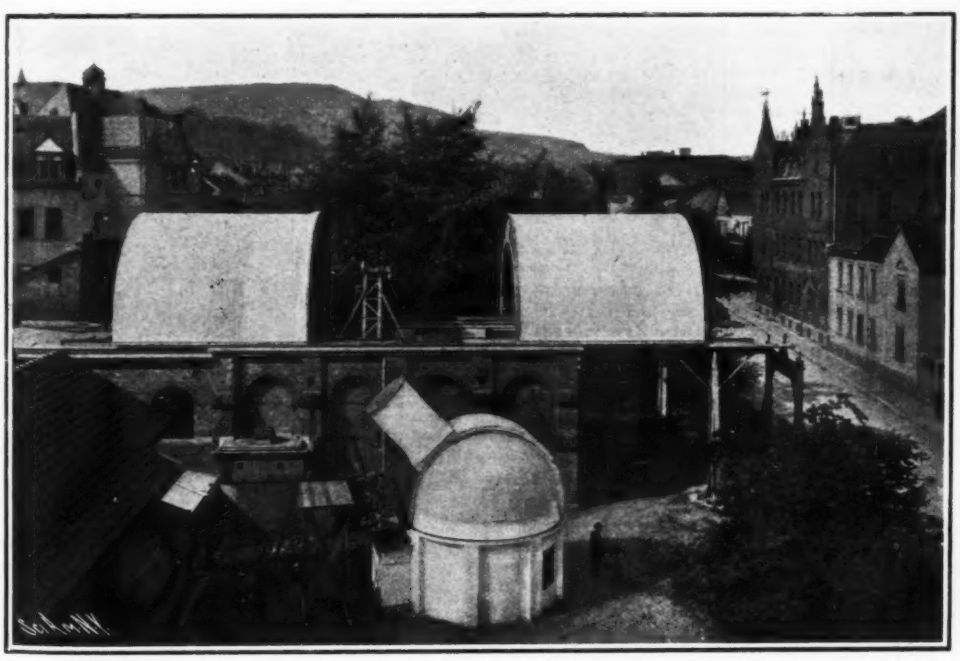


FIG. 4A.—ANOTHER VIEW OF THE ERECTING SHOP FOR ASTRONOMICAL INSTRUMENTS.

ELECTRICALLY OPERATED EQUATORIAL MOUNTINGS FOR TELESCOPES.

Jena, seems to afford a most satisfactory solution of the problem.

A special feature of this telescope mounting is the use of electric motive power.

All movable parts of the telescope must rotate round the hour axis at a speed of 15 arc seconds per time second (sidereal time) in order to cause the telescope to follow the daily motion of stars. This motion should take place in a direction opposite to the direction of rotation of the earth, while the speed as far as possible should be kept constant. In the case of the celestial bodies of our solar system, which show a motion at variance from that of other stars, the driving gear should allow of an alteration in speed slightly diverging from the average figure. Hitherto clock trains driven by weights have been employed to impart to telescopes the motion above described. Apart from the unavoidable superintendence in course of operation, this method requires the winding up of weights (at least once per hour), which is a most undesirable disturbance to the observer. Though the idea of using motor drive in place of gravity thus readily suggested itself, special difficulties were encountered because of unavoidable fluctuations in tension in a direct-connected motor and regulator. Gravity had therefore to be relied on as the most constant source of power, electrical energy being resorted to only for winding up the weights. This could be done either by using the ordinary clockwork arrangement with a relatively large weight (to be wound up by an electric motor after a given interval) or by so designing the ratio of the drive that a smaller weight, permanently wound up by a small motor, would suffice.

The automatic winding device for the weight designed on the latter plan (Fig. 1) is arranged as follows:

A weight, *G*, is attached to an endless Gall chain and continually wound up by the electric motor, *M*. A resistance, *W*, regulates any fluctuations in the speed of the motor, *M*, and the attendant vertical displacement of the weight, *G*. When these displacements reach the lowest or highest position of the weight, *G*, an automatic switch, *C*, starts or stops the electric motor. *A* is the starting switch, and *R* is a transmitting shaft for coupling the weight elevator to the regulator. The same operation, whenever the disposition of the refractor permits it, should be performed by means of the Gall chain, *C C* (Fig. 2).

The regulator, *R* (Fig. 2), is a friction spring regulator of the astatic type, in which each position of the regulator balls corresponds with a given centrifugal force, balanced by the spring. By altering the tension of the spring, the speed of rotation is readily controlled.

In most observations the above-mentioned average speed of rotation of the hour axis (15 sec. per second) will be required. With this speed the connecting rod, *T* (Fig. 2), will complete a revolution in exactly one second, while *T* transmits the action of the regulator to the telescope. Uniformity of motion of the shaft *T* is obtained by automatically checking the rotation by means of a pendulum sidereal clock. The device used in this connection comprises an electric time keeper for seconds, *S S* (Fig. 2), a friction clutch, and an electro-magnetic seconds interrupter.

Now the rotation of the regulator is so adjusted that *P* completes a revolution in about 0.97 second. During the remaining 0.03 second, up to the end of a whole second, as required for a complete revolution of the axis *T*, the armature of the electro-magnet will arrest the rotation of *T* by releasing the friction clutch. The friction disk is provided with a projecting cam which strikes a part of the armature not released before the pendulum clock has completed one second. The motion of *T*, and accordingly that of the telescope, is thus discontinued every second during the minimal interval of 0.03 second, which is quite unable to exert any disturbing influence even in connection with the most delicate astronomical work.

Another electrically operated mechanism is the electric fine adjustment for the hour and declination movement.

The slow motion necessary for keeping a given object in the same position on the cross-wires is generally obtained by convenient transmission such as used in connection with small measuring instruments. The fact that these devices should be relatively large and still sufficiently easy to operate affords some difficulty,

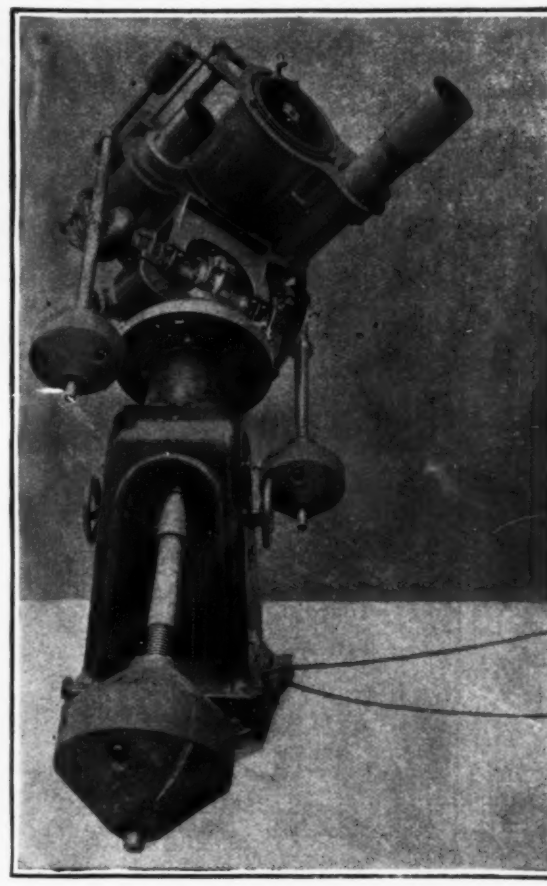


FIG. 5.—EQUATORIAL MOUNTING ELECTRICALLY DRIVEN.

the more so as the unavoidable amount of labor on the part of the experimenter quickly causes fatigue.

The ordinary mechanical fine adjustment was therefore replaced by an electrical device comprising four keys, combined in a box. The construction of this device in principle is identical for both co-ordinates, consisting of an electro-magnetic clutch which, on running at no load, transmits an average speed, while effecting an acceleration of retardation as soon as one of the two clutches is thrown in.

The motion of the observation platform and cupola (Figs. 3 and 4) is likewise effected by means of electrical devices, in order to save time in adjusting by hand.

Two different motions should be taken into account in this connection (Fig. 3), first, rotation in azimuth of the platform around the instrument, and, second, the lifting or lowering of the platform. Owing to the small distance between the eye-piece and the crossing of the axes of the instrument, the amount of adjustment in a vertical direction is rather limited.

The protective cupola of the instrument should be so designed that when the slot in the cupola is open only a relatively small part of the sky is visible. The width of the slot is further limited on purely constructive grounds. The motions required in altering the line of sight are facilitated as the cupola runs on a horizontal track consisting of a ring of balls or differential rollers.

The motor for operating the cupola may be mounted on the cupola itself, a Gall chain running along the top of the wall; the motor drives a worm gearing with a toothed-wheel engaging with the chain and

pulling the cupola around. As the slot in the cupola should follow the position of the telescope, it appears practical to couple the movement of the instrument to that of the cupola.

A METHOD OF PHOTOMETRY OF HIGH CANDLE-POWER UNITS.*

By T. B. LAMBERT.

AT the risk of being called iconoclastic I would like to destroy the candle-power unit as a standard without having anything definite to substitute in its stead, for I believe that it would be well to leave the old pathway with the one idea in view, that of finding a better one, something more practical if possible.

We might say, for instance, that one sound was twice as loud as another if the amplitude of its waves were twice as great, or assume that it would be twice as loud if it could be heard at double the distance. Neither would be correct, because the loudness of the sound depends upon the physiological effect on the human ear of him who acts as the judge. We seem to be bound up in the creed that certain effects vary inversely as the square of the distance, which, even if true to some extent, does not apply to effects on the human ear or eye. Certain sounds have a peculiar strident effect, more or less dependent upon the resonant pitch of the parts of the physical ear, and also upon the nervous condition of the individual himself, both of which should be eliminated in an instrument designed to measure the amount or quantity of sound.

I have used the measurement of sound as an illustrative topic because of its parallelism with the problem of light measurement, and the fact that we have not fallen into any errors in sound measurement is primarily because we have not been called upon to make measurements of it. And here let me state that there is just now a demand for an instrument not yet made which might be called a sonometer, for use in the telephone field. We are measuring the transmission of telephone speech over lines and instruments in a very crude manner that can lay no claim to scientific accurracy; and if someone will but devise a satisfactory method of taking these results accurately, perhaps it will, at the same time, point out a more scientific method of measuring light values than by our primitive candle-power unit.

A particular point which I wish to bring out is the comparisons of high candle-power units without reference to the fanciful systems of measurement devised by the various manufacturers to bring out the particular virtue of their several products. At the risk of being tedious, I wish to take you through the same paths that lead me to the simple method whereby the large units of light may be compared directly with small ones or with one another.

If you study the heavens some evening you will come to the conclusion that there is no mistaking the slight differences in the magnitude of the stars, mere points of light in the strictest sense, since even the brightest of them show no appreciable disk under the most powerful telescopes. Yet we note with unfailing certainty that one star is brighter than another, however small the difference. There is not as much actual illumination from all the stars together as from a common firefly at a distance of a few feet. All this simply means that our eyes are able to discern carefully and accurately between lights that are very low in intensity.

The practical commercial units such as the 8, 16, and 32-candle-power incandescent lights are so bright that the eye cannot compare their light values at all accurately, except by indirect methods such as we use in various photometric schemes. We can look at the stars of the tenth magnitude and note with certainty that one is a shade brighter than another, but to detect the difference between two incandescent lights, one of 16 candle-power and the other of 18 candle-power by direct vision, we will utterly fail; though indirectly, by letting the light from these two sources fall on a properly designed and arranged photometric screen, we can make fairly close comparisons.

If we have two units to compare and can reduce their illuminating value by a certain known ratio we can compare them with an exactness such as we compare star magnitudes. This does not take the color factor into account, which factor is solely a physiological question, and in this discussion for simplicity's sake reference is made to comparisons between lights of the same quality.

In order to reduce by a definite known ratio the quantity of light thrown on a photometric screen by a certain unit, it is only necessary to permit it to shine on the screen the desired proportion of time. If the light is shut off for one-half the time the illumination is reduced to one-half of the value; if the light is shut off for 99-100ths of the time the illumination is consequently reduced to 1-100th of the total value.

To demonstrate this plan I have equipped a simple electric fan motor with an opaque disk in place of the fan and have cut away from the disk a radial slot representing 1-100th of the entire surface of the disk, and by causing this disk to revolve at a high rate of speed between the source of light and the photometric screen the amount of light reaching the screen is thereby reduced to 1-100th of the total emission. It is only necessary that the disk be revolved at a high rate of speed to prevent the effect of flickering, which, if it occurs at the rate of 25 or more per second, is not noticeable to the eye on account of its rapidity and the phenomenon known as "persistence of vision." By this means we are able to reduce the actual light given off from an 800 candle-power arc lamp so that only 1-100th of its value will fall upon the screen, thus reducing its effect to that of an eight candle-power lamp, with which it can be compared directly on a standard photometer bar in the laboratory.

The actual value of this process depends upon its accuracy, which can be proved nicely and conclusively by constructing several disks with openings of different ratios, and one can easily prove for himself that a disk from which one-half has been cut away and run at a high rate of speed between a 16 candle-power lamp at one end of the photometer bar and the movable screen, the lamp will then compare accurately with an 8 candle-power lamp at the other end. The proportion of light passing through the revolving disk is dependent entirely upon its angular opening.

The original apparatus made for this experiment a few years ago consisted of an adjustable disk made up of two pieces so arranged that the desired angular slot could be readily provided at any value. This was done merely to prove the proposition, as later it was found more advantageous to have several solid disks attachable to the motor, which disks had been cut away according to the ratios of ½, ¼, 1-10, 1-50, 1-100 and 1-500.

When more than a very small angle was to be cut away it was found of advantage to cut one-half of the desired opening on one side and one-half diametrically opposite. This was done in order to balance the apparatus when running at high speed, and then the more the openings distributed around the revolving disk the less the tendency to flickering which might tend to spoil the results.

This was the first and basic principle under which a high candle-power unit could be directly compared with a low unit on the same standard photometer bar, and it led at once to another feature applicable to diminish the error of the personal equation, enabling the experimenter to not only repeat his own observation but verify those of others. This was accomplished by the simple expedient of reducing by the same proportional amount the light from both units under comparison; to do this one has only to run a slotted disk between the eye and the photometric screen, selecting a disk with an angular opening suited to the intensity of the light under examination. In this plan it is not necessary to know the value of the angular opening, nor is it strictly necessary to run the disk at a rate to avoid flickering, because flickering does not appear to influence results.

It might here be remarked that the revolving slotted disk method cannot be applied to a measurement of units supplied with alternating current, unless both lamps under examination are supplied by currents in exact phase in such a way that the lights would have the same relative intensity at each moment. The disk method for the examination of alternating-current lights would be dangerous in the hands of most observers. These lights could, however, be easily compared with one another or with other standards by indirect methods. By way of passing interest it can be said that the candle-power of the sun could easily be measured, and with quite reasonable exactness, by the same method. Of course it would be of no especial value to know this, except as a bit of curiosity. It is however, practically applicable to measurement of powerful searchlights.

I want to call your attention to the important work that the illuminating engineer has done for civilization. No other factor of progress and development has been so potent as that of artificial illumination, except

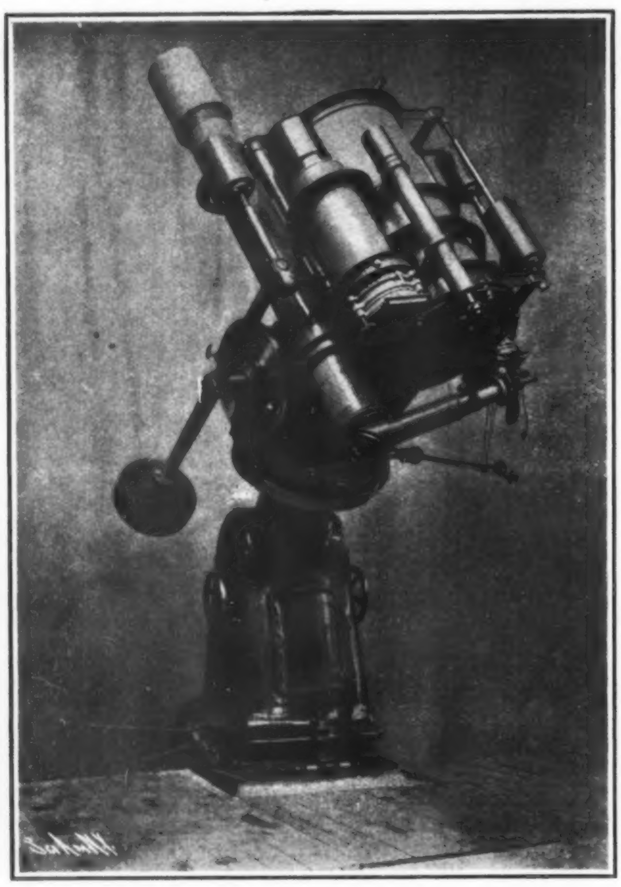


FIG. 6.—GENERAL VIEW OF THE NEW PARALLACTIC TELESCOPE MOUNTING. DIAMETER OF PARABOLIC REFLECTOR 400 MM.

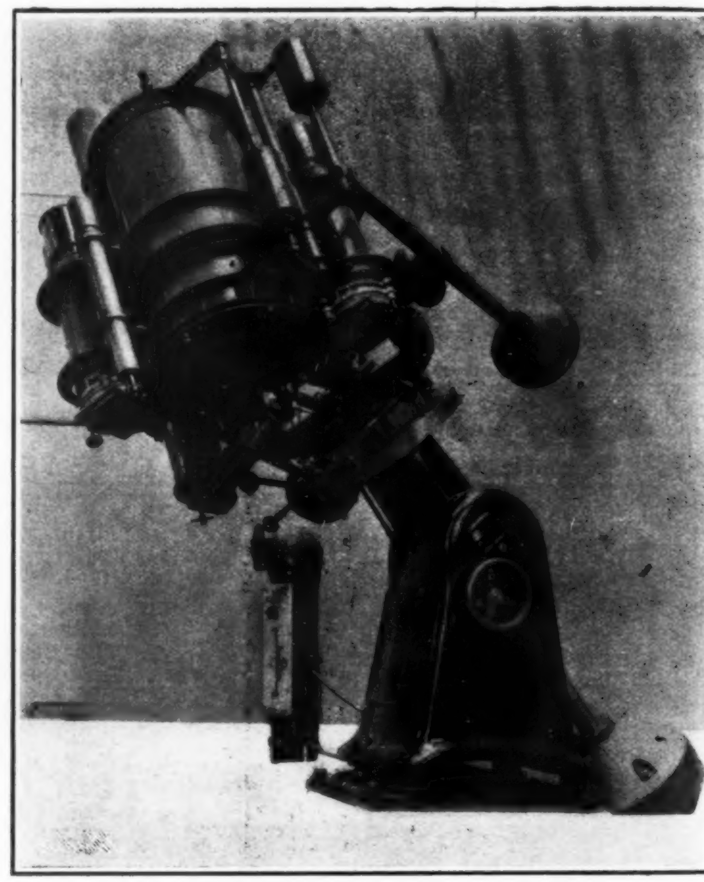


FIG. 6A.—ANOTHER VIEW OF THE ELECTRICALLY ACTUATED PARALLACTIC TELESCOPE MOUNTING.

ELECTRICALLY OPERATED EQUATORIAL MOUNTINGS FOR TELESCOPES.

* A condensation of a paper read before the Chicago Section of the Illuminating Engineering Society, April 11, 1907. The author is foreman of the light and power department of the Chicago Telephone Company.

the art of printing, and not only is the art of printing largely and directly dependent upon artificial illumination, but also indirectly dependent to a far greater extent in the lengthening of the day into the night. When we shall have learned how to absorb the sunlight and again use it at pleasure, then, and not till then, will the work of the illuminating engineer be ended.

LINNÆUS.*

By HENRY KRAEMER.

THE two hundredth anniversary of the birth of Linnæus falls upon May 23, 1907. When we consider the work which Linnæus did in the field of natural history, including botany, mineralogy, and zoology, and the profound influence which his work has had upon the subsequent development of these sciences, it is eminently fitting that this anniversary of his birth should be brought to mind and reference made to his life and work. I have always been very much impressed by the life and teachings of Linnæus, and at the close of the Columbian Exposition, in a paper which I read here at the college, and also in New York before the Torrey Botanical Club, I expressed the hope that the two hundredth anniversary of Linnæus's birth would furnish the occasion for an international botanical exposition to be known as the "World's Linnæan Exposition." (Am. Jour. Ph., 1894, p. 92.)

The great-uncle, as well as the father, of the subject of this sketch was a naturalist. The family name even was taken from a linden or lime tree, in Linnhult (Sweden), and there is a story that it began to wither on the death of the son of Linnæus, the last male member of the family. It is said that as a child the toys of Linnæus were flowers and that his mother hushed his cries by giving him flowers to play with. From the very time that Linnæus left his cradle he almost lived in his father's garden.

Carl von Linné, or Carl Linnæus, as he was more commonly known, this latter being his plebeian name, was born May 23, 1707, in Rashult, situated in the south of Sweden, in a very pleasant valley adjoining Lake Möklein. He was the firstborn, and naturally his father thought of him as perpetuating the honor of the family in becoming a minister, like himself, or possibly even a bishop, for it seemed to him that in those brown eyes there were manifestations of something more than an ordinary child.

When but four years of age and having heard his father give an informal talk on the names and properties of the plants in the vicinity of his home, Linnæus ever afterward desired, not to preach like his father, but to teach botany as he heard him that evening. He asked his father all about the plants, particularly their names.

In accord with his youthful desires, he was given, when eight years old, a plot in his father's garden to cultivate and care for as his own. At the age of ten he was sent to the grammar school at Wexio, and after being there for two years, his parents were grieved to learn that he was not considered at all fitted for the study of the ministry. The schoolmasters said: "He ought to be a tailor or shoemaker," and they advised the father not to spend any more money on the education of the boy. His father was about to act on their advice, for he considered that it was better to make a good cobbler than a poor minister of his boy. It happened, however, that about this time the father needed a physician, and being really more sick at heart than otherwise, on account of the prospects of his boy, consulted Dr. Rothmann, his physician, who prescribed not only for his physical ailments, but told him also what to do for the boy. The kind doctor said: "Suppose the boy does not want to become a minister, what is to hinder his becoming a good physician or a naturalist?" Dr. Rothmann lived in Wexio, and he not only advised the father what to do, but took young Linnæus into his own family, permitting him to continue his studies preparatory to a medical course, and in addition taught him, among other things, Tournefort's System of Botany. Before passing on, let us remember that next to being a Linnæus is to be a Rothmann.

While applying the system of Tournefort in his own gardens and recognizing its imperfections, we find Linnæus, at the age of seventeen, possessed of a desire to improve this system or invent a system of his own. At the age of twenty (in 1727) he entered the University at Lund, and after a year's study, at the suggestion of Dr. Rothmann, he continued his studies at the University of Upsala. His life here, particularly during the first few years, was exceedingly hard. His scanty pittance from home did not keep him. He was obliged to trust to chance for a meal and tried to overcome his hunger by reading books, and oftentimes was compelled to lie down until the pangs of hunger wore off. His clothes became worn and he had to mend his shoes with folded paper. At night he shivered for hours until he fell asleep, and had it not been for Artedi—then a student at Upsala and his companion in misery—it seems that he could not have born the poverty and physical suffering which he had to undergo.

And so it happened, for just as Linnæus was about to despair and return home, he met Dean Celsius, of the university, who had just returned from Stockholm after an absence of some time. The dean took kindly to him, and finding that Linnæus would be useful to him in the preparation of a book on the "Plants in the Bible," provided a home for him. It was in the library of Celsius that he saw Vaillant's work on the study of flowers, and on the basis of the latter he subsequently wrote a thesis treating of the importance of the pistils and stamens in the study of flowers, and in which he proposed a new system of classification. Dr. Rudbeck, the professor in botany, now made him an adjunctus in botany at the university, and entrusted his public lectures to him. Linnæus also arranged the botanical garden according to his new ideas and instituted botanical excursions into the surrounding country.

At this time occurred a most fortunate event in his life. He was commissioned by the state to make a journey to Lapland to study its natural history. This furnished an opportunity for him not only to make a journey of nearly 4,000 miles into that interesting country, but to crystallize out the guiding principles of his life in much the same way as Darwin did after him. He brought back with him very valuable information and important collections, and these results gained for him the approbation of the Royal Academy of Sciences.

Upon his return he resumed his lectures and was so successful that he aroused the jealousy of a colleague, and, as a result, was compelled to leave the university for a time. This was a great blow to Linnæus, but we find him within a week leading a naturalists' expedition into Dalecarlia. Returning, he settled down in the town of Falun, and lectured on mineralogy, and completed at the same time a system of mineralogy which subsequently played a most important part in the study of this science.

While residing at Falun he became enamored of Elizabeth, the eldest daughter of Dr. Moraeu. The latter, however, did not like the idea of his daughter marrying a man who did not seem to have any certain means of livelihood. He advised Linnæus to finish his course in medicine, and promised that at the end of three years, if his prospects were better, he might have his daughter. It being the custom in those days in Sweden to require students to take their degrees at a foreign university, Linnæus, in 1735, went to Harderwyk, Holland, and soon secured his doctor's degree.

He then journeyed to Leyden, where he met Gronovius, who was so impressed with his original work that he published his "Systema Naturæ" at his own expense. Through Gronovius he became acquainted with the renowned physician Boerhaave, and, upon the recommendation of the latter, he was made physician to George Clifford, a very rich man and mayor of the city, who had one of the finest collections of plants in the world at his place Hartecamp, near Haarlem. Linnæus became not only physician but also botanist to Clifford, and while here published some of his notable books, as "Genera Plantarum," "Fundamenta Botanica," "Critica Botanica," etc. In order to relieve Linnæus of a homesickness which seemed to be taking hold of him, and in order to secure material for his collections, Clifford sent him to England. He visited the famous botanical gardens at Chelsea and Oxford, and became acquainted with the great English botanists of that time. Dillenius was then at Oxford, and while he was at first somewhat suspicious of Linnæus, he was soon so impressed with his ability that he urged him to stay in England, and offered to share his salary with him.

Linnæus returned, however, to Holland with a large collection of plants for Clifford's gardens, but still possessed of the idea of returning home. He shortly left for Paris with a heart overflowing with gratitude to Boerhaave and Clifford, and for the land that had adopted him, and would have made him a professor at Utrecht. At Paris he met Bernard Jusieu, other famous scientists, and men of letters as well. He visited the various botanical gardens and saw the systems of Tournefort and Vaillant applied in a practical way. He had opportunities of familiarizing himself with the famous herbaria in Paris, which contained the type specimens of Tournefort and others. The Royal Academy of Sciences elected him a member and offered him a salary if he would but remain in Paris. Linnæus, however, still held to the notion of returning home, believing that if he had any merits they were due to his own country.

He eventually succeeded as a medical practitioner, and became in time the fashionable physician at Stockholm. Meantime he married, on June 26, 1739. In 1741 he was elected professor of physics and anatomy in the University of Upsala, and in 1742, by an exchange of chairs with Rosen, he realized the crowning ambition of his life and that was to be the professor of botany in his alma mater. Here he continued until his death in 1778. Thus, at the age of thirty-four, were his highest ambitions realized. He was in his native country, which he had learned to love more than ever. He was back at his alma mater, the source of his inspiration.

One of the most powerful factors in spreading the influence of Linnæus was that of his pupils. They came from all parts of the world and were impressed by the strength of his character and the originality of his teachings; and each in turn acted as a missionary, as it were, to spread his new doctrines. As an instance, we may mention that one of his students, Grulberg, took Ray's Synopsis, which had been the pocket companion of every English botanist, and revised it according to the system of Linnæus. This revision was so much simpler than the imperfect system of Ray that it soon replaced the latter. According to the new system, botanical gardens were laid out, botanical collections were named, and botanical lectures were given in nearly all the institutions of learning in the world by the young men who were Linnæus's students.

Honors came thick and fast. Linnæus received medals and orders from home and abroad and was elected to membership in all the leading learned societies. One of his biographers says that he was acknowledged to be the "Prince of Botanists," and another that he was "ruler of the empire of natural history and sovereign of the kingdom of botany."

That these encomiums were not exaggerated is attested by the fact that Linnæus described all the animals, plants, and minerals of his time; that he enunciated the principles of defining genera and species, and has left his permanent influence on the biological sciences by the invention of his system of binomial nomenclature. "He found natural science a chaos and left it a cosmos."

His name is also associated with the history of the microscope, and he threw some light on the subject of the relation of micro-organisms to disease. He was among the first to consider the subject of dietetic medicine, and gave a decided impetus to the cultivating of economical and medicinal plants and advocated the replacement of animal drugs by vegetable substances. He saw in the strata of the earth the markings of the periods of geologic time.

Linnæus seems early to have learned that to do some big things one must not even attempt too many little things. Thus to him the mere mastery of a language was little compared to the knowledge which might be gained by such an accomplishment. While Linnæus never mastered any other languages than Swedish and Latin, yet he may be said to have created a language.

He was keen in recognizing the benefits of foreign travel, yet recognized also the great importance of traveling in one's own country, and delivered a remarkable oration on this subject which had much to do in developing the resources of Sweden. He said: "He who goes abroad raw and ignorant seldom returns more learned. Yet, I speak to you, gentlemen, not of the peculiar advantages of universities, or of sojourning at this rather than at a foreign one; but chiefly of traveling in one's own country, through its fields and roads—a kind of traveling, I confess, hitherto but little used and which is considered fit only for amusement."

A man like Linnæus was bound to come under the fire of criticism. Fortunately for him, Boerhaave taught him never to answer attacks. Just criticism, however, was always welcome to him, and in a characteristic letter to Haller, he said: "The more errors of my own that you can point out, the more I shall be obliged to you. By such means I may be enabled to correct all that is wrong before I die, for no one can amend his own work in the grave."

He discoursed not on morals or ethics, but in his veins there streamed naturally the pure red blood of the manly man. What greater compliment could have been paid him, even had he been a bishop, than when Rousseau said to him: "I draw more profit from your 'Philosophia Botanica' than from all the books on morals."

We might delineate Linnæus's characteristics further, but enough has been said to show how many-sided his character was, and how valuable his life is as a biographical study. Surely in the life of this great man we must find an example and inspiration for each to do his part in contributing to the knowledge of the world and to the welfare of mankind.

* Part of a paper read at a pharmaceutical meeting of the Philadelphia College of Pharmacy.

MEANS FOR RETARDING THE SETTING OF PLASTER.

THE rapidity with which good and properly calcined plaster sets is in many respects a source of trouble, where it is used for casting and modeling, so that many attempts have been made to discover means of retarding this setting and of producing a plaster mass, which after the lapse of minutes, even hours, it will still be possible to use for casting, but more especially for modeling.

One of the simplest mediums that can be used to retard this setting is glue water, and the more concentrated the solution of glue, the longer the setting may be delayed. In the manufacture of picture frames, a knowledge of this fact is made use of in the production of the plastic mass, which possesses the additional merit of acquiring great hardness. An addition of 4 to 8 per cent of althea (marshmallow) root powder produces a plaster that sets very slowly. The dry plaster is mixed with the pulverized root and the whole kneaded with 40 per cent of water to a paste. In consequence of the large proportion of pectine contained in the marshmallow root (50 per cent), we obtain a mass resembling a rich clay, which does not set until after an hour, and is then so hard and tough that it can be filed, turned, and bored, and which can be employed for many purposes besides plaster casting. In a mixture of gypsum with 8 per cent of powdered marshmallow root, the setting is protected for a much longer period and the toughness of the mass increased. It can be spread, with the aid of a beetle, on glass surfaces in large, thin sheets, which will not break when dry, are easily detached from the glass and by simple rubbing acquire a high polish. Where ochers and other coloring substances have been incorporated with the mass, it can be made, by proper kneading, to produce very fine imitations of marble. It can also be tinted after drying, with colors dissolved in water and afterward made waterproof by soaking in linseed oil varnish and lacquering or polishing. The locksmith can greatly increase its hardness, by mixing with it his iron filings, the picture frame maker will never have any occasion to fear the cracking of his wares; according to its fineness and purity the gypsum will

require a slight percentage more or less of water, which makes it impossible to define the exact quantity to be used. For many purposes it is not necessary that the marshmallow root powder be of the finest quality.

Dr. Wühling recommended, as a means of retarding the setting process, the addition of 2 to 25 per cent of alcohol in making up the plaster mass, whereby the setting could be postponed for seconds, even for hours. The alcohol, which is volatilized, exercises no detrimental effect on the plaster mass, and plaster casts made with water containing alcohol are always more dense than those made with plain water.

If too much alcohol be added, however, the plaster mass will not set and is then useless.

Milk, whey and casein, are also recommended as retarding the setting of plaster.

Another medium for delaying the setting of plaster casts is the saturated solution of borax in water; before using it, the borax solution is diluted with water, the extent of the dilution being governed by the time for which we desire to defer the setting process. The following proportions have been tested and found reliable.

1 volume of borax solution, diluted with 12 volumes of water, retards the setting 15 minutes.
1 volume of borax solution, with 8 volumes of water, delays the setting 30 minutes.
1 volume of borax solution, with 4 volumes of water, retards the setting for 3 to 5 hours.
1 volume of borax solution, with 2 volumes of water, delays the setting process 7 to 10 hours.
1 volume of borax solution, with 1 volume of water, retards the setting 10 to 12 hours.

The periods differ again, according to the character of the various materials employed. The best method of producing a saturated solution of borax is to dissolve the borax in boiling water, then allow the solution to cool. The fluid that separates from the deposited crystals represents, at ordinary temperature, a saturated solution of borax.

A NEW DIRECT-READING WIND GAGE.*

By Dr. Alfred Gradenwitz.

The apparatus so far used for measuring the speed or intensity of the wind may be divided into two classes, according as they either indicate instantaneous values, or record an average figure relating to the interval in question. Most of the instantaneous apparatus are based on the thrust exerted by the wind on a surface of given area, free to move so as to be placed in a zero position in the case of calm weather, from which it is deflected through an angle corresponding with the intensity of the wind. The suction effect of the moving air current has likewise been used for this kind of measurement.

In most of the above described devices special means had been provided continually to turn the surface acted on toward the wind. Apart from the smallness of the range available with these devices, the necessity of a special directing vane greatly impaired the accuracy of the measurements.

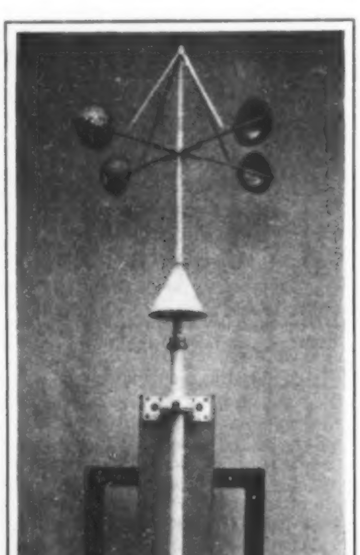


Fig. 1.—KOHL'S WIND GAGE.

In the novel wind gage constructed by Max Kohl, of Chemnitz (see Fig. 1), the instantaneous values are recorded accurately without the necessity of a directing device to turn the apparatus against the wind. The "Robinson cup cross" is made use of in the apparatus, consisting of a cross constituted by two iron rods which are horizontally fixed on a vertical rotating shaft. To each of the four branches of the cross, which are of exactly the same length, a metal hemisphere is attached. This cross always rotates in a forward direction when the wind strikes the hemisphere. The shock against the concave side is always greater than that striking the convex side. The direction of the wind being thus indifferent, there being only one direction of rotation, the wind intensity at any given moment can be fully utilized, thus losing no time in adjusting the apparatus to an alteration in the direction of the wind. While the Robinson cross was formerly used in ascertaining the average figures of the wind intensity, its axis operating a speed meter, it is here used for the first time in measuring the instantaneous values.

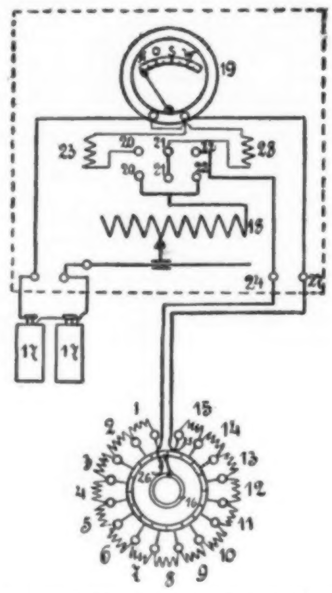


Fig. 3.—ELECTRICAL CONNECTIONS OF GEYER'S WIND GAGE.

A wind gage recently constructed by Max Kohl, of Chemnitz, Germany, on plans by E. Geyer, Altenburg, renders it possible to read the direction of the wind both by night and day and at any desired distance from the apparatus proper. This wind-gage is therefore especially available for use in meteorological stations.

The apparatus as seen from Fig. 2 includes two light aluminium vanes of lengthened triangular shape, which are inclined with regard to each other, being separated by suitable rigid connecting pieces, so that the wind, after the apparatus has adjusted itself, will strike at the same angle two surfaces of equal size and shape. This double vane obviously shows the advantage of a safer and more accurate adjustment, while the remaining mechanical arrangement warrants the highest possible sensitiveness, the vanes themselves being counter-balanced by a sliding weight and the vertical axis located in ball bearings, so as to warrant an easy running of the apparatus.

In Fig. 3 is shown how electricity is used to transmit the readings of the apparatus to any desired place. It may be said that the apparatus, so far from being confined to the use of any given tension, may be connected both to the constant tension of lighting circuits and to a small stationary battery without any necessity of sending part of the existing tension through a permanently inserted resistance. In Fig. 2 is shown an apparatus, the electric gage of which is operated by a small battery including two dry cells, the underlying principle being as follows:

A resistance varying according to the position of a switch comprising sixteen contacts and communicating with the wind-gage is connected with the source of current, the circuit containing an ammeter, the index of which is deflected as far as the terminal mark of the scale in case no resistance is inserted. The scale is divided uniformly between zero and the terminal mark, the resistances inserted in the various positions of the switch being so graduated as to have the index moved through one division as the switch advances from one contact to the other. The sixteen contacts of the switch being arranged round the rotary axle of the wind-gage, correspond with sixteen different directions of the gage, and as each alteration in the position of the apparatus results in a corresponding alteration in the position of the index on the measuring instrument, the divisions of its scale may be standardized immediately in wind directions, thus enabling the actual direction of the wind to be immediately read off the electrical measuring instrument.

The switch has been given the shape of a current collector as usual in connection with direct-current dynamos. Such a commutator, including mica-insulated lamellæ, affords an extraordinary safety in operation, warranting a permanently satisfactory contact. It may be mentioned that a conductive copper brush allows the current to pass without any appreciable friction losses due to the motion.

The several lamellæ, as seen from Fig. 3, are connected to fifteen resistances, 1 to 15, and to a sliding ring, 16, the commutator with the resistances 1 to 15 as well as the sliding ring 16 being attached to the axle of the wind-gage, while the brush 25 is fixed in front of the commutator and the brush 26 in front of the sliding ring. Only these parts are mechanically connected to the wind-gage, while all the remaining devices, being arranged on a small switchboard, are connected to the former only by means of two wires.

The current coming from the battery, 17, may be so regulated by means of the hand-regulator, 18, as to cause the measuring instrument, 19, to show a deflection as far as the last division in case of absence of any resistance. The circuit is generally switched out by the switch, 20, 21, 22, provided with a breaking position. If this switch be so arranged as to connect the contacts 21 with the contacts 20, the resistance 23 will be inserted in the battery circuit behind the measuring instrument, 19, thus serving as checking resistance. Its magnitude has been so calculated as to about equal the conduction and transition resistances contained in the measuring circuit if all the resistances, 1 to 15, are switched off. The index of the ammeter thus points to the last division also on inserting the checking resistance so as to enable the tension of the battery to be checked before each set of measurements or even before each reading. By displacing the slide of the regulating resistance, 18, the normal tension can be readjusted for.

On making measurements the lever of the switch, 21, 22, is so arranged as to connect the contacts 21 with the contacts 22, when a perfect circuit will be constituted from the zinc pole of the battery through the resistance 18, the contacts 22, 21, 21, 22 of the switch, terminal 24, brush 26, sliding ring 16, and, e. g., through all the resistances 1 to 15 (as according to Fig. 2), brush 25, terminal 27 and ammeter 19 to the carbon pole of the battery. According to the magnitude of the inserted resistance, the index of the instrument will point to a given division of the scale, thus indicating the actual direction of the wind.

It may be mentioned that the wind-gage itself does not perform any mechanical work worth speaking of, both the friction in the ball bearings and that of the brushes being exceedingly small. The apparatus does not require any appreciable superintendence.

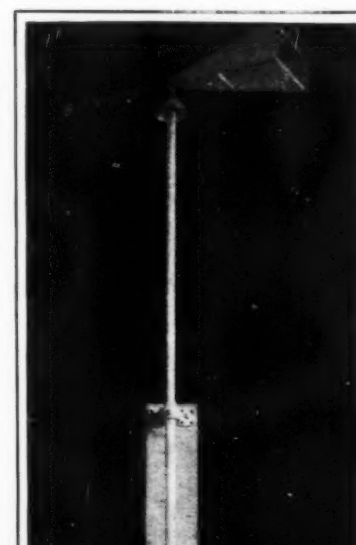


Fig. 2.—GEYER'S WIND GAGE.

A lecture was recently delivered by Mr. Alfred Hands, F.R. Met. S., before the Royal Engineers at Chatham on "The Protection of Buildings from Lightning." In the course of his remarks he showed the impossibility of protecting buildings efficiently by means of set rules; each case had to be studied separately, and the system of protection applied which the complications of metal in and about the structure showed to be necessary. Hitherto too much importance had been attached to the form and composition of the conductor and too little to the fact that its efficiency depended almost entirely on the way in which it was applied and very little on what it was. He regarded the subject as somewhat analogous to the work of a medical practitioner. The conductors in the hands of an expert were comparable to the drugs a physician might find it necessary to prescribe according to his diagnosis of the case. No one could claim infallibility, and anyone might overlook some factor that might have an important bearing on the case, but the fact remained that the possession of knowledge, experience, and an ability to discriminate as to the importance of details should enable a man to protect a building effectively, while absence of these would very probably result in failure. At all events, it was in this direction he thought we

* Specially prepared for the Scientific American Supplement.

should strive to improve our methods, and not in trying to devise theoretically perfect but practically impossible mechanical ones. As regards the relative value of iron and copper for conductors, he considered the matter, so far as concerned conductivity and the dissipation of energy, to be of such trifling importance that it sank into insignificance in comparison with considerations of durability. A lightning conductor was expected to last for a long time, and iron was unfortunately too perishable for the purpose. As regards cost, an iron system, if of sufficient size to be fairly lasting, would be more costly than an ordinary copper tape one. Mr. Hands said that vagaries or freaks of lightning were an impossibility, and the belief in such was due only to the cases being wrongly reported. There were laws governing all natural phenomena, and lightning, like every other force in nature, must be amenable to law. Where they appeared at first sight inexplicable we should try to clear up the mystery, and not dismiss the matter by saying that in one respect nature was erratic.—From The Engineer (London).

PROGRESSIVENESS IN ITALY.

LARGE DRAINAGE PLANT AS RELATED TO MOSQUITO EXTERMINATION.

By HENRY CLAY WEEKS, Secretary A.M.E. Society.

THE American Mosquito Extermination Society stands strongly for all means which will accomplish its object—the principal of which are the reclamation and drainage of saturated lands—salt or fresh. Its propaganda has already resulted in deep interest being taken in plans for draining extensive mosquito-breeding lands in many States, with their ultimate use for agricultural purposes, in some cases, so that the extermination idea means not only comfort and healthfulness, but involves many economic advantages which possibly otherwise would never have been contemplated.

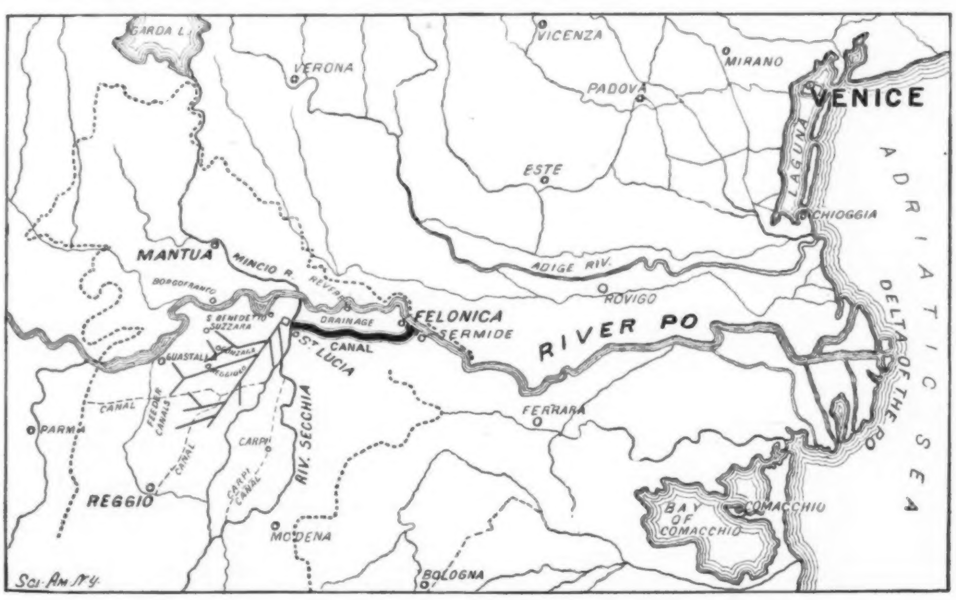
THE PRINCIPAL SIPHON.

Construction of the pipes under the new course of the Secchia. Just prior to covering in with the cement hood.

The SCIENTIFIC AMERICAN SUPPLEMENT of May 20, 1899, and January 5, 1901, first sounded the note for this larger campaign, and there has since been a steady advance. An appeal to the general government to take part was made as early as January 15, 1901, and again on January 7, 1903, and thereafter its soil survey of Long Island was made, encouraging the reclamation of salt marshes. In 1904 the Department of Agriculture started the Drainage Investigation, and has done some very important work in the meantime. A letter from Dr. Elwood Mead, chief of that division, says: "It is now engaged in collecting information for a report on the reclamation of the tide marshes of the Atlantic seaboard. While this report will deal principally with the benefits to agriculture, the improvement of the public health will not be overlooked." This department has already backed up proposed plans in numbers of cases, and has thus given authoritative aid in local movement. The government and the South Carolina Sanitary and Drainage Commission are co-operating in a survey of the swamp and tide lands in that State. Larger appropriations this year will enable broader drainage investigations by the government.

And yet the United States is behind some other countries in this respect. Italy is to have its great Pontine marshes reclaimed, and a deadly territory made valuable and habitable. The American Mosquito Extermination Society, learning of the great engineering scheme to reclaim the fertile valley of the Po, whose waters annually overflow from the melted snows of the Alps and the Apennines and leave large tracts of alluvial land covered with pools, which become stagnant and pestiferous, asked the government to have made a report on this work as encouragement for relief of many situations in the States. This very interesting report has recently been completed by our consul at Milan, and is here submitted by the society through the courtesy of the State Department and the editor.

[We make the following extracts from the report above mentioned.—ED.]



APPENDIX A. THE RIVER PO, DRAINAGE CANAL, AND SECCHIA RIVER.

Its title is as follows: An Italian Drainage Canal. The Great Bonifica dell'Agro Mantovano-Reggiano which has reclaimed nearly 80,000 acres. Milan, Italy, February, 1907.

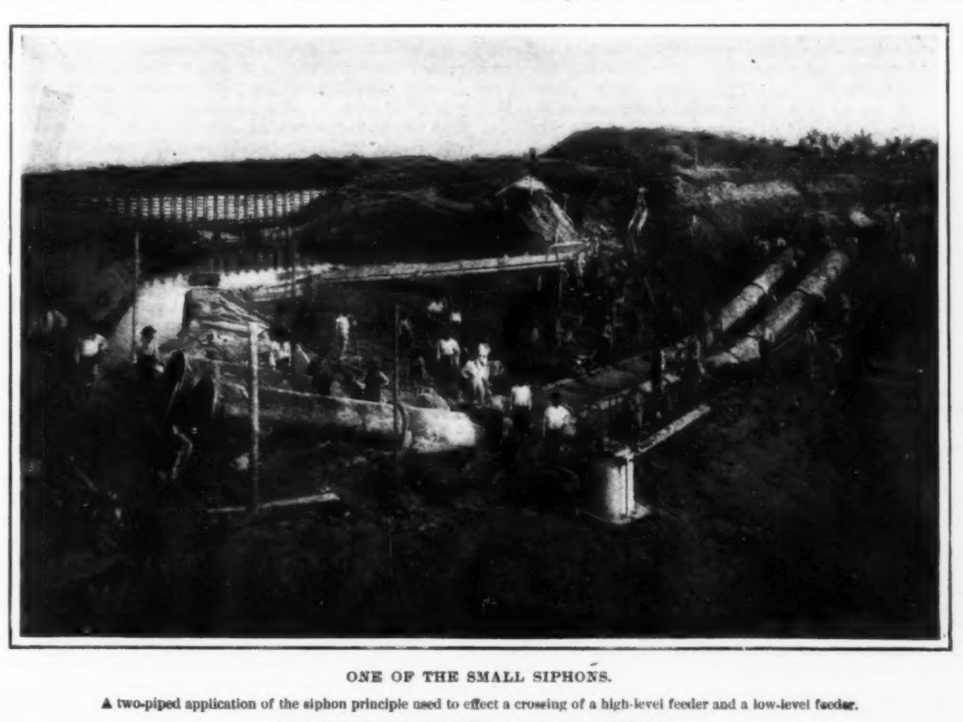
The river Po has a length of 416.64 miles, and its source is in the west Alps at a height of 6,402.56 feet above sea level.

The fall of the river Po averages 15.365 feet per mile, and it is navigable for 348.44 miles from its entrance into the sea. It drains and waters alternately a territory comprising 39,325 square miles. It has carried down so much alluvial soil that a delta has been formed extending inward from the Adriatic Sea a distance of 50 miles. This has so dammed up the flow as to cause the river to overflow its banks above and produce numerous ponds and lakelets, whose level is now 64.41 feet above the sea level, and great tracts formerly dry are now overflowed. There was no way to drain these lakelets by natural means, and this surplus water, standing in stagnant ponds of sundry differing levels and from which arose, during the tropical weather of the north Italian summer, the most noxious vapors, greatly interfered with the health of the inhabitants. Mantua was a fever district, yet it was rich agriculturally on account of its peculiar alluvial cultivable soil.

Not only the public health, but the physique of live stock have long been subject to epidemics of malaria, epizootic, and other diseases arising from neighboring swamps; while poisonous insect life has thrived to a threatening extent.

Early in the nineties, Italian engineers of the first class had their attention called to the desire for reclamation manifested by the citizens of Mantua and the adjoining province of Reggio. The late Ettore Zapparoli of Mantua, an eminent expert and graduate of the Milan Polytechnic Institute, devoted himself assiduously to a study of the field, and in July, 1899, succeeded in having his preliminary project approved by a royal decree at Rome. In brief, his plan was to collect the stagnant water by means of a system of small and outbranching tributary canals, bring it by that means to one point, introduce it there by either pumps or siphons to a main-line canal, and by carrying it far enough down the gradual descent of the river valley, deliver it into the Po at a point sufficiently below the level of the drained land and its surroundings to assure a constant flow.

The project was actively discussed, and met with



ONE OF THE SMALL SIPHONS.

A two-piped application of the siphon principle used to effect a crossing of a high-level feeder and a low-level feeder.

ITALIAN DRAINAGE CANAL SYSTEM.

some opposition from certain communes through which the proposed main-line canal was to pass. Mr. Zapparoli's death in 1899 left the plan still undeveloped, and gave it something of a setback. But the need was so great, and the agricultural interests of Mantua and Reggio were so persistent in demanding practical attention to their increasing importance, that the committee in charge of the matter finally turned over everything in the case to Engineer Luigi Villoresi of Milan, himself a famous canal constructor, and descended from a family the name of which is perpetuated in that of the principal internal waterway of Italy, built by his grandfather to give the metropolis of Milan connection with the Italian lakes. Mr. Villoresi took the accumulated notes and raw specifications and incidental governmental decrees and committee reports of sixteen years, and the history of flood damages in Mantua and Reggio following the disastrous overflow of 1879, and put them into shape. The government required that within one year he have his plans drawn; that within two years thereafter he begin work; and that within six years from the date of beginning work, he deliver the completed system ready for operation. That he did so, and that the work was so well done, is in Italy regarded as his greatest achievement, and he was given an important decoration by the King in honor of his skill.

The Villoresi plan followed the general lines laid down in the original project, and took shape along this general scheme:

1. To separate the surplus water on the high land levels from that on the low levels by a system of dykes and barriers subdividing the affected region.

2. To unite the water collected in the affected territory (that is, collected through the existing system of old canals and such new construction as proved necessary) at a point near the river Secchia, which enters the Po from the south near where the Mincio enters it from the north; and carry it off therefrom by means of a main-line canal.

3. To establish in these canals a system of locks and headworks by means of which the water could be held at any level during the dry season, and used for irrigating the land when it had been reclaimed and put under cultivation.

This involved the entire systematization of the old existing canals, to bring them to standard levels and to deepen or divert them with a view to the purposes of the greater plan; and when the case came to the point where complete standardization of the numerous differing levels forced itself to a decision, it was seen that the river Secchia was the key to the whole scheme of drainage. If the reader of this report will refer to the map attached hereto as Appendix A, he will see the situation immediately. The upper Po, backed by the tremendous fall of its higher sources, comes to an end just west of Pavia, a little south of Milan. The middle Po extends from Pavia to the mouth of the Mincio. This middle section has a channel from 5,000 to 10,000 feet wide as it sweeps around the great curve before Mantua and makes a sharp turn straight to the north for several miles before turning east again, dividing Mantua from Reggio and thence entering the lower river. The lower river is narrow and, with the ever-increasing deltafication going on at its mouth, serves to back the water upstream and over into the low lands which surround this wide right-angular sweep. The river Secchia is a winding and troublesome streamlet, very dry (as its name implies) in summer when water was badly wanted; and in spring always running over its banks and slopping into the low country, through which it flowed despite the dykes built to hold it in its course. Hydrometer tests at Felonica and Sermide, on the lower Po, where it was planned to have the main-line drainage canal empty its waters, established an above-sea-level mark of 19.31 feet as the key level of the whole system. Working back from that as a base, the maximum high level of the tributary feeder canals was established at 20.79 feet above sea level, a total fall of 1.48 feet in a total distance of about 25 miles over all, and of 19.26 miles in the main-line canal. But when the engineers under Mr. Villoresi's direction came to justify the feeder and delivery systems to these bases, it was discovered that the river Secchia not only lay straight across the way to the lower Po, but that its level and its vagaries were such as to render it an apparently insurmountable obstacle.

It was accordingly decided to siphon the drainage under the Secchia, and to divert that river into a specially built and buttressed channel with that object in view, thus guarding against changes in the river's course or damage to the siphon system itself. It was further determined that by way of maintaining the base levels without variation throughout the entire system of feeder canals, siphons should be used to pass the low-level water under the canals used for carrying the high-level water to the junction point at the head of the main-line canal. In short, it was the design to so lay the canals of varying levels that by force of gravity alone the water would run into the principal siphon established near the river Secchia's west bank and not far from the Po itself, and from there be passed, by natural means only, into the main line.

Thus the old canals were rebuilt and systematized and releveled so that all parts of the two provinces to be drained were served, and that all emptied into a trunk feeder leading down to the Secchia. This main feeder, around which and connecting with which all the tributaries were laid, is 2½ miles in length. Its section has a bottom beam of 28 feet, and side walls sloping at 4.92 feet in 3.28; or, using the metric symbols in which the work was done and from which the report is translated, 1½ meters in 1. Its mean fall per foot from its highest point to its lowest is 0.00011808 foot. Its capacity is 764.90 cubic feet of water per second, which is the base number on which was figured the delivery of the flow into the main-line canal and of that portion of the work itself. The trunk feeder was dyked along its upper portions. At its point of delivery into the main line, under the Secchia, it has headworks containing gates which are used to shut off the flow when it is needed in the fields in summer. There are six of these headgates at this point. More than a dozen old canals were taken into the system and justified so as to flow into the trunk feeder. In each of them the water can be turned back by the use of headgates at such seasons as it is needed.

THE SIPHONS UNDER THE RIVER.

The trunk feeder drains into a bank built just west of the river Secchia, and from that into a series of four siphons which pass under the artificial cement bottom of the new river bed. The engineers selected a remarkably sinuous portion of the Secchia, less than one mile from the Po itself and nearly opposite where the Mincio joins the Po on the north bank. As will be observed by reference to the map, the section selected was shaped like a letter U, and the new channel was built across the uprights, connecting them, while the curve was used to carry the water around the work until it was completed. The new channel was excavated to the right depth, and its banks were buttressed with stone and granite blocks to prevent landslips and seepage. At the ends of the new channel flaring dykes were built out on either side, to secure the chance overflow of the river and keep it within the course chosen for it. Experiments made during the excavation of the channel showed with absolute proof that it would have been impossible to turn the Secchia into the main-line canal and thus dispose of the difficulty in a comparatively simple way; for not only was the level of the river such as to render that method undesirable, but the soft under-soil, frequently approaching the condition of quicksand, made it entirely impossible. Accordingly, the river was channeled in a new course to its natural outlet, and the drainage system was siphoned underneath it and carried on to the lower Po for ultimate delivery.

To carry the siphons and secure them against the undermining effect of the river's flow, a bed of cement, built on piles and concrete, was laid from the west bank of the artificial channel, down its slope to the bottom, across the bottom to the east bank, and up that slope to the level of the mouth of the main-line canal. The siphon pipes are 13.12 feet wide, 9 feet high, and 482.28 feet in length. They are built of brick and mortar in vertical arches, reinforced across the top with steel beams, and the whole placed under a cement hood. There are headgates on either side of the channel for controlling the flow of water through the pipes. Cement and stone were laid at intervals along the new channel to give it stability. When it was ready, the river was let in and carefully dyked out of its old course. The work of constructing the main-line drainage canal (Il Canale Emissario) proceeded.

THE MAIN-LINE CANAL.

From the east bank of the new channel of the river Secchia, the main-line canal runs in a slightly southeasterly direction in a series of long curves, and enters the lower Po at Felonica, a little north of Sermide, where the river makes another right-angular sweep, this time due south. Its course, which can be traced without difficulty on the map included in the photographs accompanying this report, or to somewhat less advantage, on the large lithographed map Appendix A, is 19.26 miles in length over all and about 12 miles between termini. More exactly speaking, it begins in the district of Quistello and the village of Santa Lucia, at the Secchia near the Po, traverses the communes of Quingentole, Pieve di Coriano, Revere, Borgofranco sul Po, Carbonara di Po, and Sermide. It crosses numerous old canals and important highways, to accomplish which there was demanded the construction of 26 siphons, 58 manholes, and 41 bridges. Some of the bridges required special attention, and every care was taken to render them not only serviceable but artistic in a simple way.

The main canal has a fall per foot from its high end to its mouth of 0.000131 foot. Its section is 28 feet in beam at the bottom, with side slopes of varying height but at an angle of 4.92 feet in 3.28 (in the metric table, 1.50 to 1). The territory traversed by the canal is naturally lower than that of the reclaimed acreage above the Secchia, so that it has been necessary to line the course with dykes. These dykes, which are simply the side slopes of the canal carried above the land level, measure 16.40 feet at the top and vary in height from 23.62 inches at the head of the canal to 18 feet as the canal reaches its outlet in Felonica.

The soil disturbed by the excavation of the canal could probably have been applied to the erection of the dykes, and in such a way as to have rendered outside excavation for this purpose unnecessary. That is, there was considerable surplus dirt in the upper sections of the canal even after the low dykes required there were built. Instead, however, of moving this surplus down the line and applying it to the erection of the higher dykes called for in that part of the work, it was left where it lay and turned over to the abutting landowners. This was very probably a sop to Cerberus, though it is impossible to get anyone in authority to admit it. There was some local opposition to the construction of the main-line canal, not only on the grounds usually taken by landholders in questions of the kind, but because of certain more or less logical fears that it might upset the equilibrium of the existing canal systems in the region through which it was to pass. At all events, the opposition was overcome, and the rich soil taken out of the upper sections, and not needed in building the dykes, was given to the farmers and used by them for making fills in their land.

Hence, when the work reached the lower sections, the excavations did not give enough dirt to build the 18-foot dykes called for at that point. To supply the deficiency diggings were made at contiguous uncultivated points not less than 50 feet from the line of the canal. The series of open pits thus created were subjected to the same exact standardization of bottom level which had been applied to the canal system itself; and in order that they might not become unhealthful receptacles for stagnant water, were connected by ditches with the neighboring old canals, to the levels and pitch of which the diggings had been adjusted.

At the outlet of the main canal the principal headworks of the system were constructed. These consist of pump house and headgates at the very mouth of the canal, and of a supplementary gate house 165 feet up the canal. Both are fitted with three headgates 14.25 feet high and 6.56 feet wide.

This 165-foot lock afforded by the space between the two gate houses is used to regulate the flow of water to the pumps in a full season, or to hold back the water in the main body of the canal in the dry season when irrigation is in progress. Under ordinary conditions the canal empties direct by gravity into the lower Po at this point. Should the river rise above the canal level, however, the headgates are closed against the consequent backflow, and the canal is emptied by steam pumps which lift the water above the river pitch. During pumping operations the lock is used to regulate the flow upon the suction pipes, and during repairs to the principal apparatus to shut it off altogether. In short, the main canal is at once a drainage ditch and a storage basin; and there are twelve minor sets of headworks in the feeder system to assist in the storage of water during irrigation.

THE SYSTEM IN USE, AND ITS RESULTS.

While there has not yet (February, 1907) been afforded one full year for the study of the system in operation, certain tests have shown that in its drainage and reclamation function it is a sure success. For instance hydrometric tests in the old canals, which before the completion of the new system were intended to drain into the middle Po and the Secchia, showed that from July, 1896, to February, 1897, in 245 days of official observations, the drainage remained stagnant during 164 days, 127 of which were consecutive. This was in the most unhappy part of the ten swampy communes. Other tests in the part specially selected for certain advantages enjoyed by its canals (being on the higher of the low levels) gave, out of 245 days of observations, 100 days during which the canals did not function, 32 of them being consecutive. When it is remembered that this stagnant condition lay in the heart of an otherwise noteworthily productive agricultural section, the need of corrective works becomes apparent. It was the original estimate of the engineers that they could so readjust the canal system to the levels to be established and the fall to be created in the main-line ditch, that there would be a constant flow for not less than 14 days in 245 of consecutive observations, and this proportion has been borne out by the short year during which the system has been in actual use.

The area drained may be stated in tabular form thus, in acres:

	Communes.	By Old Canals.	By New Canals.	Total.
Mantua.	Suzzara	5,086.48	5,941.42	11,027.89
	Motteggiana	2,550.91	1,018.10	3,569.01
	Gonzaga	111.89	11,028.46	11,140.35
	Pegnognaga	1,303.32	9,329.88	10,633.20
	Moglia	....	5,643.19	5,643.19
	S. Benedetto	44.76	10,573.34	10,618.10
Reggio.	Guastalla	....	6,828.65	6,828.65
	Reggiolo	3,032.80	6,902.40	9,931.20
	Luzzara	5,317.85	1,774.20	8,092.05
	Rollo	216.00	168.00	384.00
	Total acreage	17,600.01	59,267.64	77,867.64

It is, of course, obvious that in this table the figures show the acreage now drained by the old canals as readjusted to the new system, plus that of the new canals necessary for the completion of the project. In fact, no part of the old drainage system was lost, but was justified into the new.

On February 10, 1906, the drainage from Mantua-Reggio entered the Po at Felonica for the first time, and the working of the system since that date has been satisfactory. Drainage has been accomplished. No defects of importance have appeared. It has been demonstrated in every way known to the engineers that there can never be a repetition of the costly floods of 1879, when not only were the fields overflowed, but the existing drainage and irrigation system was washed out at numerous vital points. The middle Po and the erratic Secchia have been completely deprived of the terrors which they formerly implied at certain seasons of high pitch, while the water which ran to an unprofitable waste during the dry time is now stored and made use of in agriculture.

While it is as yet impossible to know by comparison of figures what benefits to agriculture will be apparent in the first year of operation of the Bonifica, a brief review of the products of the affected province

of Mantua, as an example, is significant. In 1905, for instance, Mantua had a total population of 315,500 persons, of whom 69,000 men and 27,000 women, or 96,000 persons, were engaged in agriculture. During that year these persons raised 1,875,000 bushels of wheat, 1,988,000 bushels of maize, 227,000 bushels of oats, 511,000 bushels of white rice, 300,000 quarts of wine, 200 tons of silkworm cocoons, and 42,000 tons of hay in four crops. Also in 1905 they put into the market 130,000 beeves, 2,300 sheep, 875 mules, 2,800 asses, 45,000 swine, and 15,000 horses. Such figures, in the circumstances, speak eloquently in favor of good drainage.

The results of the improved drainage system may be stated as follows:

1. In both Mantua and Reggio this tract, comprising 77,867 acres, cultivable only for a sparse crop of poor hay and, on account of the vapors arising from its stagnant swamps, dangerous for pasturage during practically all the year, has been made cultivable, in one year, for wheat, grapes, fruits, and hay, and rendered good for cutting into farms on which people can erect homes in safety.

2. The market values not only on the 78,000-acre tract but on all contiguous territory, even to the outer bounds of the affected provinces, have leaped to figures equal to two or three times those prevailing before the opening of the Bonifica, i. e., from $120 to $250 or $300 per acre.

3. Farm labor, which formerly expressly avoided these provinces, and made difficult the harvesting of the extensive crops, has been attracted there by the changed conditions; while on account of the demand created by the active development of the drained tract, wages have not been knocked down by the plentitude of supply.

4. Live-stock maladies are under better control.

5. The public health has been afforded a sure and scientific protection.

If this statement of results is too summary, it is not because the consulate is not possessed of actual data with which to set up a good and sufficient proof; but because details of data have intentionally been avoided as of no direct importance to the American reader. Further, it is manifestly unreasonable to expect, even in a productive land like Italy, that results could be made entirely obvious in less than one year of operation. But, taking the total acreage under cultivation in the one province of Mantua, for instance, and deducting therefrom as an example an average acreage equal to the acreage in Mantua drained by the Bonifica, the following is apparent:

PRODUCTS OF 53,000 AVERAGE MANTUAN ACRES DURING THE YEAR 1905.

Wheat	187,500	bushels.
Maize	198,800	bushels.
Oats	22,700	bushels.
Rice	51,100	bushels.
Wines	30,000	quarts.
Cocoons	20	tons.
Hay	4,200	tons.
Beeves	13,000	head.
Swine	4,500	head.
Horses	1,500	head.

Strictly inexact as this comparison must be, the above table shows what, in 1905, the average Mantuan acreage of equal area did; and the soil, climate, fertilization, irrigation, and drainage were the same as will obtain in the reclaimed territory when the Bonifica has had time to do its work. There is no reason for supposing that the reclaimed area will not rise to the above average. Before the Bonifica, it grew one miserable crop of semi-poisonous grass.

Referring to the better protection of the public health, stated in item 5 above, it appears from an examination of the vital statistics in Reggio and Mantua that typhoid fever, intestinal disorders, and diseases specially concerned with irritations of the alimentary canal have been prevailing in significant proportion to the total. While the number of such maladies has not been in any way sensational, local physicians have recognized the swampy communes as their direct cause, and as a special drawback to an otherwise uncommonly healthy region. Here again the Bonifica is too new to show exact results, while on the other hand all considerations of logic indicate the only line along which it will be possible for the results to lie when they have been given time to appear.

Commercially, the Bonifica has transformed a half-wasted tract into typically fertile and abundant Italian farm lands.*

A. THE COST OF CONSTRUCTION.†

The total cost of the Bonifica was $3,200,000, which was expended as follows:

Land expropriations	$640,000
Excavations	1,350,000
Headworks and machinery	770,000
Direction	100,500
Sundry extras	339,500
	$3,200,000

The cost of cement and other material, which was proportionately small, is included in the item of machinery. Under the sundries item are placed costs of damages of various kinds, repairs to tools and construction machinery, etc.

The original plan placed six-tenths of the total cost of the Bonifica on the Italian general government, two-tenths on the ten communes affected by its service, and the remaining two-tenths on the abutting owners of farm lands to be reclaimed; so that the sum which the work came to cost would be divided thus:

Italian government	$1,920,000
Abutting owners	640,000
Communal governments	640,000
	$3,200,000

The original plans called for a total expenditure considerably less than the actual cost of the work; but the abutting owners and the communal governments have paid their shares of the increased cost, and it is expected that Parliament will authorize an appropriation which will enable the government at Rome to do likewise. The tables of differences may be approximated in this manner:

Work.	Estimate.	Actual cost.
Land expropriations	$345,000	$640,000
Excavations	800,000	1,350,000
Headworks, etc.	460,000	770,000
Direction	50,000	100,500
Sundry extras	143,800	339,500
Totals	$1,798,800	$3,200,000
		$1,798,800
Difference		$1,401,200

The difference, though great, will be understood by American engineers who realize the uncertainty of work with river foundations. It was the unfavorable character of under-soil developed by the attempt to pass under the river Secchia (referred to previously) which created the first great item of increased cost in the construction of the system. Torrential spring-time currents above, and quicksands below, threatened to render useless both the elaborate plans made by the engineers and the work already carried out according to their terms. In the face of every discouragement, Mr. Villoresi went on putting in the cement and stone buttresses, until he had a permanent artificial channel which no amount of tumbling snow water can wash out.

In the outside work, from 4,000 to 6,000 men were kept constantly employed, the wage scale for labor of this class in Italy (30 to 50 cents per day) being an important item in keeping down the total cost, though undoubtedly offset in an interesting degree by the more easy-going methods of superintendence in vogue in the country and by the innumerable holidays. The men were hired by contract under the usual "padrone" system, but their work was directed by the engineers. A staff of thirty sub-engineers and clerks was maintained at Mantua, and office expenses amounted to about five per cent of the total cost.

B. THE COST OF OPERATION.

The cost of operating the Bonifica system is reckoned to be $16,000 for every good and average year; that is, one during which the machinery will not be used for more than 20 days out of the 365. (The year's test to which the system has been put indicates that that is a fair proportion of days when the natural working of the system must be given artificial assistance.) The maximum estimated cost of operation for a "bad" year, that is, one in which the condition of the lower Po and of the Po valley as a whole is such that the river pitch is above that of the main-line canal, is $26,000, the additional expense being made necessary by the use of the pumps at the mouth of the canal, which is thus kept perfectly clear of water even in seasons when there are floods outside. The pumps, which were particularly among the features of the system introduced by Mr. Villoresi when he took charge of the work, are of 350 horse-power each, and together have a capacity for the delivery of 1,765.72 cubic feet of water per second to a height of 9.84 feet. These pumps, which are of Italian make, are a reserve force to be used only when unfavoring conditions render gravity insufficient to keep the system clear.

Hence, the cost of the Bonifica was $41.60 per acre for construction, and 20½ cents per acre for operation; these being flat estimates minus interest charges and so forth, and the operation charge being based on "good" year observations.

FINANCING THE WORK.

As has been shown above, the interested communes and the abutting owners contributed each two-tenths of the total cost of the Bonifica. Their shares, however, were covered by the government's appropriation, in order that funds might be immediately available without making burdensome assessments upon the farm population; the government, in other words, advancing the money and taking its own time for the collection of the shares of the communes and the abutters. To supply the funds for the work of expropriation and construction, the Parliament gave authority for a royal decree in 1899 which empowered the executive committee of the Bonifica commission to make an issue of bonds amounting to $2,040,000, each bond to have a face value of $100 and to bear interest at 4 per cent. The entire issue was bought by the Banca Commerciale of Milan. It is now expected that the government will make up the difference in the cost of construction necessitated by the expensive nature of the work with the river Secchia.

AUXILIARY WORKS.

There were used in connection with the main work a complete railway line (steam) for the moving of earth and bringing up material; an electrical power plant of 100 horse-power, driven by a steam engine, for transmitting energy throughout the system for application to drills, hoists, carriers, and other mechanisms; a special telephone system with a wire line 30 miles in length; cement machines, steam pumps, pontoons, derricks, and the usual supplementary apparatus, most of it built specially for service on the Bonifica.

SUNDRY STATISTICS.

The total canal work, new and old, excavated and systematized was 55.89 miles in length, including the whole system. Seventy-three bridges were erected or rebuilt throughout the system to carry railways, tram lines, and roads. Between March, 1901, and December, 1905, inclusive the offices paid time on 2,143,797 days of labor to workmen. Accidents incident to the work of construction numbered 1,125.

IN CONCLUSION.

The Bonifica, in spite of the fact that its first practical plans were drawn by another, is actually the work of Engineer Villoresi, "whose modesty of language and demeanor," remarks one of his acquaintances in discussing his achievements, "is equaled only by his skill." Though he took up the work when it was in what appeared to be a state of good completion as to preliminary plans, it was his genius alone which rendered possible the systematization and full use of the old and then useless canals; which met the extraordinary difficulties discovered on attacking the river Secchia and not contemplated in the original designs; and the addition of a pump system which would allow the drainage system to function throughout its entire length regardless of outside conditions.

Associated with Mr. Villoresi was the commission, organized under royal decree, of nine men of both national and local importance, the president being Engineer Cavaliere Achille Zavanella.

The designs of the Bonifica have been awarded a diploma of honor at the Turin Exposition of 1898; a diploma of honor and a gold medal at the Bologna Exposition (Italy) of 1899; the grand premium at the Naples Exposition of Hygiene in 1900; and another grand prize at the St. Louis Exposition in 1904.

ELECTRICAL NOTES.

On the trial section of electric railroad at Oranienburg is to be used an electric locomotive of the most recent construction in order to make a series of tests upon a new system which is being brought out by the Allgemeine Company, of Berlin. The new locomotive will be built for 1,000 horse-power, and some details as to the electric motors which will be used here have been obtained. Single-phase alternating current is to be used on the locomotive, and the motors, which are of the six-pole type, will be run at 500 revolutions per minute, and will then be in synchronism with the alternating current. When running at the normal rate, the motor will develop 250 horse-power at the above speed, and is claimed to have a much higher efficiency than the usual traction motors. Gearing which has a reduction ratio of 4.15 is used from the motors to the driving wheels of the locomotive. Using 350 horse-power on the locomotive, the running speed is 15 miles an hour, and the tractive effort 3.85 tons. At the start, the tractive effort rises as high as 5.0 tons. Using three motors on the locomotive, we have a tractive effort of 14.85 tons. The high speed rate of the locomotive is 30 miles an hour, and here the motors run at 780 revolutions per minute. Owing to the good system of air cooling which is used here, the weight of the motor can be reduced to 6.1 tons, and it does not heat much. A force feed lubrication is used on the motor bearings coming from a pump which works in an oil tank mounted on the body of the motor.

The influence of magnetism upon the electric conductivity of metals was the subject of a conference made recently by Leo Grünbach, of Berlin. He had made a series of experiments relating to transverse magnetization of metals, using in the first place the series of diamagnetic metals and second the magnetic compounds of iron. The wires were rolled in spiral, and the spirals were placed perpendicular to the lines of force of a powerful magnetic field. Precautions were taken to prevent errors which might come from variations of temperature. The tests showed that the magnetic and diamagnetic metals acted quite differently from the iron series. Both paramagnetic and diamagnetic metals showed an increase of electric resistance under the influence of the magnetic field. The variation of resistance is first very strong with the increase in intensity of the magnetic field, and then for a certain intensity of field it increases almost proportionally. With palladium the increase in resistance persists for half a minute after the field is withdrawn. According to the value of variation in resistance in the magnetic field, we may classify the metals as follows: cadmium, zinc, silver, gold, copper, tin, palladium, lead, platinum, tantalum. The magnetic metals, iron, nickel, cobalt, behave quite differently, and it is found that their electric resistance diminishes under the action of the field. Certain kinds of impure iron commence by showing an increase of resistance. M. Grünbach expects to furnish some further results in the near future.

* While the gain by taxation cannot be yet determined, it is safe to estimate that the Province of Mantua will soon be receiving about $100,000 annually directly and indirectly from the reclaimed tract, of which the general government will receive about $30,000, leaving about $70,000 to be applied against the province's share of $384,000 on the cost of the Bonifica. Reclamation has effected a gain in land value in the drained tract alone of $300,000 not to mention general advances in adjacent communes. All these figures are approximate estimates only.

† Amounts will be stated in approximate round numbers, in United States terms.

TRADE NOTES AND FORMULÆ.

Glycerine Cement.—This cement, which can be relied upon in all cases where a cement is required which will be water-tight, permanent, and impervious to the action of oils, acids, and temperature, is composed of litharge and glycerine. The litharge must be powdered as fine as possible, and the glycerine very concentrated, syrupy, and clear. The cement is easily made by thoroughly mixing the litharge and glycerine till a soft viscid pulp is formed. It is used principally for panes in aquariums, also for metals exposed to heat. It becomes so hard that it can only be removed with a hammer, and hardens so rapidly that it must only be prepared for immediate use. It may also be used for fitting tools into wooden handles. The process of cementing them in is carried out exactly as with gypsum. The mass is poured into the cavity, and the article is inserted. As the cement is very soft at first, any excess pressed out during the process can be easily removed and the place cleaned.

Protection Against Gnats and Mosquitoes.—In the Zeitschrift für Hygiene und Infektionskrankheiten Messrs. M. Otto and R. O. Neumann have published the results of numerous exhaustive experiments on the stings of mosquitoes. They have tested the efficacy of about thirty different preventives, prominent among these being the volatile oils, which by reason of their powerful odor seem to be peculiarly adapted for this purpose, and they have arrived at the conclusion that of all these preventives only clove oil, caraway oil, cassia oil, and cretic oil (oil of Spanish hops) in concentrated form or diluted with olive oil in the proportion of 1 part to 10 parts will keep off these insects, and that only for a short time. They are also of opinion that the irritation caused to the trachoma by the volatile oil, and not, as might be supposed, the powerful odor, is the effective agent in preventing the insects from stinging. When the irritation vanishes, the mosquitoes become troublesome again, in spite of the frequently very penetrating odor of the different substances. From the article in question it may be concluded that clove oil is the most suitable for practical purposes. Whether it can be used with advantage by every one must, however, remain an open question. Apart from the not very pleasant smell, it must be remembered that these oils cause more or less irritation to the skin, and may produce a cutaneous eruption in persons with a delicate skin if used for a long time. Nevertheless, it is probable that clove oil will render valuable service for a time in most cases.

Polishing Substances.—The composition of red or white polishing mass varies according to the material to be polished and the kind of polish required. The white mass is employed almost exclusively to impart a high polish to nickel, German silver, zinc, etc., also to brass. The process of preparation is simple. Finely powdered Vienna chalk is melted together with stearine oil and tallow, the tallow being added to give consistence to the mass. When a very high polish is not required, pumice stone, washed and ground fine, may be substituted for Vienna chalk. In the yellow, or rather the red, polishing mass the yellow Vienna chalk is replaced by an iron oxide specially prepared for polishing purposes, the so-called English or jeweler's red. Commercial Paris red (rouge) contains many impurities; it is therefore advisable to wash it in thin soda lye before using it for polishing. For very high polish an English red may be made by dissolving green vitriol in water and well filtering the liquid. A solution is made in the same way with sorrel salt; equal parts of both solutions are then mixed and heated to 60 deg. C. (140 deg. F.) The resulting yellow deposit is washed and annealed in an iron vessel with moderate heat. The delicate red powder formed by this process can be used immediately, and mixed with stearine oil and tallow to a paste. With regard to the proportions of these ingredients, it is sufficient to point out that English red is the polishing substance, the stearine oil being added as a lubricant, and the tallow to give consistence to the mass. A small admixture of rosin is advisable.

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